

Code for Algo:

```
1  #!/usr/bin/env python3
2
3  import time
4  import pickle
5  import numpy as np
6  import matplotlib.pyplot as plt
7
8  def save_key_to_file(file_path, key):
9      ...with open(file_path, 'wb') as f:
10         ...pickle.dump(key, f)
11
12
13  def load_key_from_file(file_path):
14      ...try:
15         ...with open(file_path, 'rb') as f:
16             ...return pickle.load(f)
17         ...except FileNotFoundError:
18             ...print(f"Key file {file_path} not found. Ensure the key exists.")
19             ...return None
20
21
22  def caesar_cipher(text, shift, encrypt=True):
23      ...shift = shift if encrypt else -shift
24      ...result = ""
25      ...for char in text:
26         ...if char.isalpha():
27             ...shift_base = 65 if char.isupper() else 97
28             ...result += chr((ord(char) - shift_base + shift) % 26 + shift_base)
29         ...else:
30             ...result += char
31      ...return result
32
33
34  def generate_key_matrix(keyword):
35      ...matrix = []
36      ...seen = set()
37      ...for char in keyword.upper() + "ABCDEFGHIJKLMNOPQRSTUVWXYZ":
38         ...if char not in seen and char != 'J':
39             ...seen.add(char)
40             ...matrix.append(char)
41      ...return [matrix[i:i + 5] for i in range(0, 25, 5)]
42
43
44  def find_position(char, matrix):
45      ...for i, row in enumerate(matrix):
46         ...if char in row:
47             ...return i, row.index(char)
48      ...raise ValueError(f"Character {char} not found in matrix")
49
```

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47 def playfair_cipher(text, key, encrypt=True):
48     ...matrix = generate_key_matrix(key)
49     ...text = ''.join([char for char in text.upper() if char.isalpha()])
44     ...text = text.replace("J", "I")
43     ...processed_text = []
42     ...i = 0
41     ...while i < len(text):
40     ...     ...if i == len(text) - 1 or text[i] == text[i + 1]:
39     ...         ...processed_text.append(text[i] + 'X')
38     ...         ...i += 1
37     ...     ...else:
36     ...         ...processed_text.append(text[i:i + 2])
35     ...         ...i += 2
34     ...result = ""
33     ...for pair in processed_text:
32     ...     ...a, b = pair[0], pair[1]
31     ...     ...row1, col1 = find_position(a, matrix)
30     ...     ...row2, col2 = find_position(b, matrix)
29     ...     ...if row1 == row2:
28     ...         ...col1 = (col1 + (1 if encrypt else -1)) % 5
27     ...         ...col2 = (col2 + (1 if encrypt else -1)) % 5
26     ...     ...elif col1 == col2:
25     ...         ...row1 = (row1 + (1 if encrypt else -1)) % 5
24     ...         ...row2 = (row2 + (1 if encrypt else -1)) % 5
23     ...     ...else:
22     ...         ...col1, col2 = col2, col1
21     ...     ...result += matrix[row1][col1] + matrix[row2][col2]
20     ...return result
19
18
17 def mod_inverse(matrix, modulus):
16     ...det = int(round(np.linalg.det(matrix)))
15     ...if det % modulus == 0 or np.gcd(det % modulus, modulus) != 1:
14     ...     ...raise ValueError("Key matrix is not invertible modulo 26.")
13     ...det_inv = pow(det % modulus, -1, modulus)
12     ...adjugate = np.round(det * np.linalg.inv(matrix)).astype(int) % modulus
11     ...matrix_inv = (det_inv * adjugate) % modulus
10     ...return matrix_inv
9

```

```

15 def hill_cipher(text, key, encrypt=True):
16     ...n = int(np.sqrt(len(key)))
17     ...matrix_key = np.array(key).reshape(n, n) % 26
18     ...if not encrypt:
19         ...matrix_key = mod_inverse(matrix_key, 26)
20     ...text = text.upper().replace(" ", "")
21     ...if len(text) % n != 0:
22         ...text += "X" * (n - len(text) % n)
23     ...result = ""
24     ...for i in range(0, len(text), n):
25         ...vector = np.array([ord(char) - 65 for char in text[i:i + n]])
26         ...transformed = np.dot(matrix_key, vector) % 26
27         ...result += ''.join(chr(int(num) + 65) for num in transformed)
28     ...return result
29
30
31
107
32
33 def read_file(file_path):
34     ...try:
35         ...with open(file_path, 'r') as file:
36             ...return file.read()
37     ...except FileNotFoundError:
38         ...return ""
39
40
41
42 def write_to_file(file_path, text):
43     ...try:
44         ...with open(file_path, 'w') as file:
45             ...file.write(text)
46     ...except IOError:
47         ...pass
48
49
50
51 def measure_time(cipher_func, text, *args):
52     ...start_time = time.time()
53     ...cipher_func(text, *args)
54     ...return time.time() - start_time
55
56
57

```

```

5 def run_timing_tests(file_path):
6     ...input_text = read_file(file_path)
7     ...if not input_text:
8         ...print("No text to process. Exiting test.")
9         ...return None
10    ...shift = load_key_from_file('caesar_key.bin')
11    ...playfair_key = load_key_from_file('playfair_key.bin')
12    ...hill_key = load_key_from_file('hill_key.bin')
13
14    ...caesar_encrypt_time = measure_time(caesar_cipher, input_text, shift, True)
15    ...caesar_decrypt_time = measure_time(caesar_cipher, input_text, shift, False)
16    ...playfair_encrypt_time = measure_time(playfair_cipher, input_text,
17    ...                                     playfair_key, True)
18    ...playfair_decrypt_time = measure_time(playfair_cipher, input_text,
19    ...                                     playfair_key, False)
20    ...hill_encrypt_time = measure_time(hill_cipher, input_text, hill_key, True)
21    ...hill_decrypt_time = measure_time(hill_cipher, input_text, hill_key, False)
22    ...text_length = len(input_text)
23
24    ...encryption_times = [caesar_encrypt_time, playfair_encrypt_time,
25    ...                    hill_encrypt_time]
26    ...decryption_times = [caesar_decrypt_time, playfair_decrypt_time,
27    ...                    hill_decrypt_time]
28
29    ...return encryption_times, decryption_times, text_length
30
31
32 def plot_graph(encryption_times, decryption_times, text_length):
33     ...bar_width = 0.35
34     ...index = np.arange(len(encryption_times))
35
36     ...fig, ax = plt.subplots(figsize=(10, 6))
37
38     ...bar1 = ax.bar(index, encryption_times, bar_width,
39     ...               label='Encryption Time', color='blue')
40     ...bar2 = ax.bar(index + bar_width, decryption_times, bar_width,
41     ...               label='Decryption Time', color='green')
42
43     ...ax.set_xlabel('Cipher Type')
44     ...ax.set_ylabel('Time (seconds)')
45     ...ax.set_title(f'Encryption and Decryption Times for {text_length} characters')
46     ...ax.set_xticks(index + bar_width / 2)
47     ...ax.set_xticklabels(['Caesar', 'Playfair', 'Hill'])
48     ...ax.legend()
49
50     ...plt.tight_layout()
51     ...plt.show()

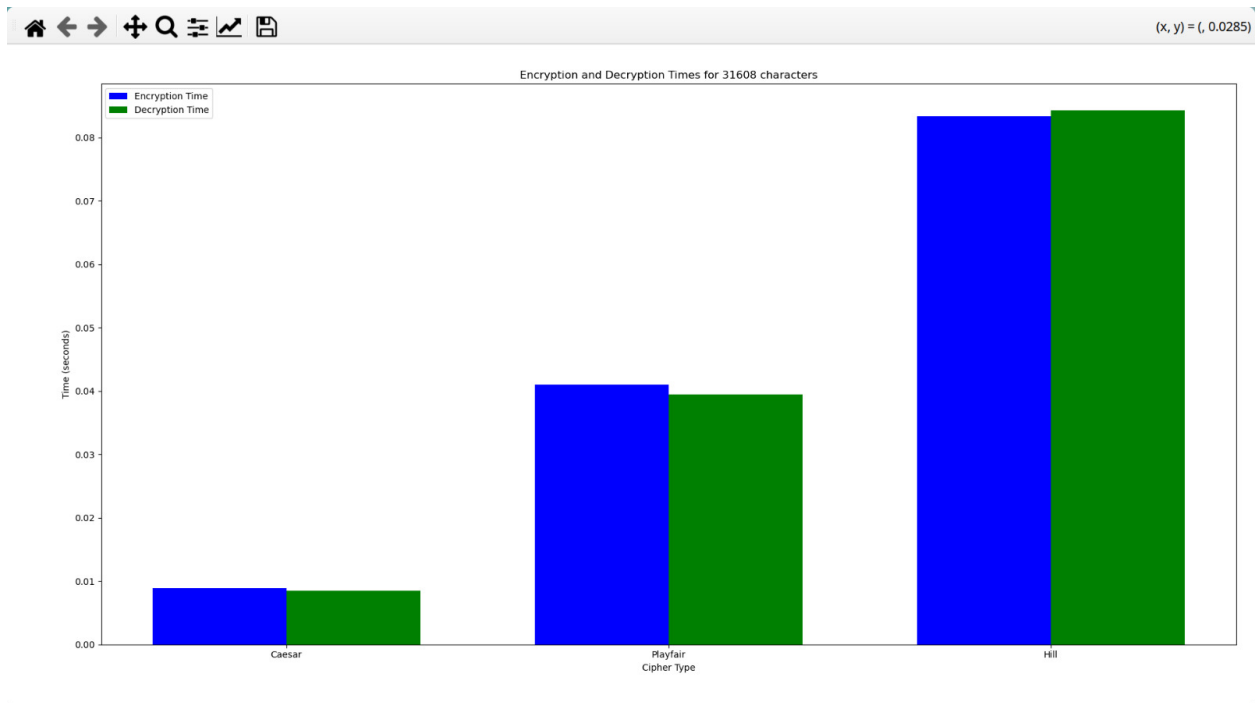
```



```

3 def menu():
4     ...while True:
5         ...print("\nChoose an action:")
6         182 ...print("1. Encrypt and Save All Ciphers (Caesar, Playfair, Hill) to Files")
7         ...print("2. Decrypt and Save All Ciphers (Caesar, Playfair, Hill) from Files")
8         ...print("3. Test Encryption/Decryption Time for a File")
9         ...print("4. Plot Encryption/Decryption Times")
10        ...print("5. Exit")
11        ...choice = input("Enter choice (1-5): ")
12
13        ...try:
14            ...if choice == '1':
15                ...input_text = read_file('text.txt')
16                ...caesar_encrypted = caesar_cipher(input_text, 5, encrypt=True)
17                ...playfair_encrypted = playfair_cipher(input_text, "REALKEY", encrypt=True)
18                ...hill_encrypted = hill_cipher(input_text, [11, 2, 19, 5, 23, 25, 20, 7, 17], encrypt=True)
19
20                ...write_to_file('caesar_encrypted.txt', caesar_encrypted)
21                ...write_to_file('playfair_encrypted.txt', playfair_encrypted)
22                ...write_to_file('hill_encrypted.txt', hill_encrypted)
23
24                ...save_key_to_file('caesar_key.bin', 5)
25                ...save_key_to_file('playfair_key.bin', "REALKEY")
26                ...save_key_to_file('hill_key.bin', [11, 2, 19, 5, 23, 25, 20, 7, 17])
27
28            ...elif choice == '2':
29                ...caesar_decrypted = caesar_cipher(caesar_encrypted, load_key_from_file('caesar_key.bin'),
30                encrypt=False)
31                ...playfair_decrypted = playfair_cipher(playfair_encrypted, load_key_from_file('playfair_key.
32                bin'), encrypt=False)
33                ...hill_decrypted = hill_cipher(hill_encrypted, load_key_from_file('hill_key.bin'), encrypt=False)
34
35                ...write_to_file('caesar_decrypted.txt', caesar_decrypted)
36                ...write_to_file('playfair_decrypted.txt', playfair_decrypted)
37                ...write_to_file('hill_decrypted.txt', hill_decrypted)
38
39            ...elif choice == '3':
40                ...file_path = './text.txt'
41                ...times = run_timing_tests(file_path)
42                ...if times:
43                    ...encryption_times, decryption_times, text_length = times
44                    ...print(f"Encryption Times: {encryption_times}")
45                    ...print(f"Decryption Times: {decryption_times}")
46
47            ...elif choice == '4':
48                ...file_path = './text.txt'
49                ...times = run_timing_tests(file_path)
50                ...if times:
51                    ...encryption_times, decryption_times, text_length = times
52                    ...plot_graph(encryption_times, decryption_times, text_length)
53
54            ...elif choice == '5':
55                ...break
56
57        ...except ValueError:
58            ...pass
59
60    menu()

```



Choose an action:

1. Encrypt and Save All Ciphers (Caesar, Playfair, Hill) to Files
2. Decrypt and Save All Ciphers (Caesar, Playfair, Hill) from Files
3. Test Encryption/Decryption Time for a File
4. Plot Encryption/Decryption Times
5. Exit

Enter choice (1-5): 3

Encryption Times: [0.008197307586669922, 0.04004311561584473, 0.08252263069152832]

Decryption Times: [0.008174657821655273, 0.03955388069152832, 0.08244729042053223]

FINAL VIEWS:

The **Caesar cipher**, as one of the simplest substitution methods, excels in speed due to its straightforward approach. It can encrypt and decrypt messages almost instantaneously. However, this simplicity comes at the expense of security, making it highly vulnerable to brute-force attacks with just 25 possible shifts. It highlights how prioritizing speed over security results in weak encryption that is easily compromised.

The **Playfair cipher**, more sophisticated than Caesar, encrypts and decrypts letter pairs instead of single characters. This additional complexity enhances security compared to Caesar but also increases the time required for processing. While it provides only moderate security, the time it takes for encryption and decryption is reasonable given its improved protection.

The **Hill cipher**, employing linear algebra and matrix operations, delivers a much higher level of security. However, this comes with increased computational demands, resulting in slower encryption and decryption. Despite its enhanced security compared to Caesar and Playfair, its high resource requirements limit its practicality for everyday use.

Encryption:

Keys:

Caesar: Shift by 3

Playfair: WHICH

Hill: [11, 2, 19, 5, 23, 25, 20, 7, 17]

1. CAESAcacR Encrypted:

TCMKEAGSLZBVQHRXFJWPYONUTSDIKGCPAHXRUEJOMBNDZWLTYCSPARVOMFBEUQNIDJKWHYSGLOXCPAHBTMUSKRQVDZNJOFGIEWXRLCS
OPTUBKQMNHJVGIRESAWDLFYQCXOMKPUNBJRHGSFTZEQVYADJOWMSPUBNGKIROFLHCTAQXEWJZNDMSVGOPUFYBEKWJQLRICZXHDNPAUSO
GMFKBETCJWYQDVRHNZLXIPIUOASGBMKETFQYJWCZNOPAXHRMDUGSELYIBCQVTJKWFMDNUZQROPJYHXAEGSLVCIWTKMFKPUDQOYZBXNRJCSL
MEGKAFIPTBNUSORQXWYHJZOMVQGCEALWPRUKNFYTSGBXBJMOQVALZNRDGEKPTYXUFCASBQLWJOMNGKVRDEZSHQYPTFBUANIWXCISOQ
REJZKGDHYMPUFXTVBSAWILCONJRGKQEUYZDXTMPBAIWFYFONSLUVGCRJQKEPAZOHBTXSWNGMFYUQKVPDCILJOZRGTESHBXUNQYAWMPCFDI
KRHEOZSLJXTAGBQVPYNWMKUFDIZSHOJLBTAIXCGRNPWEQUYMFVKTOSAIZBLCNRJPWMDGQXVYEUOKSFTBRCQHINJWPAZGMKULSXOVEYDFR
OQBHTNMWJCZXGAPSKEUNLTBMQHYDICOJZEGSRWQKPAUINXMOYCHRFATLQDJWKEGSUPZVMNIBXROYLFCTDAQJUKSPMRWNNOXHVEBYGZF
IQTBCDNXUPWKMYHJEALSROZFTVQXUGBAOWNYDJMPIECLSKRFGZUHAOPBTVQXWYNDIJRGLBECOKFSZUAPQTHVNYMIEJWRXOSKCDUJLGGPZ
FMYWJTNHVSBUOCEQKARFZPXWYTSNDGJMVLCUBQEIAOKZRWPYUNSXJMGFCLEBETZDKVROAIXPHYBFWQJMCUNGSOULTZKDRQYVBAXFMCELIJ
UGNPOWSTHBVKRZDXYQAIPOMNCLWFUJYVSBETGRKZUOAMHPWFNIQSDXCTBGJKYVLQROPUEAWMBZXHCNLYQSOVIGBETJKWDXRMAFCIZNO
HSQYWAVBDLKCEJUTGNMIOIRQFSYAZKLHRWBUVMEXCJDAOIPNTZBLUSQGCYHMKFRVWEGXAQPOSCJMNULTYDKIBHZVFOQEWRMACXNPSYZG
QJVQFTRUBHCILMOXDNAYPSPFWQVTMGBJZUOEDLINASKPXYRQCGMOZWYLVXFTJNBUDCSKHERPAOQZTGMNIWFSJVXLUYAPHCBRTWOQKMFZ
GDCUYXNJRILSAPQHBZVKMTGEOWIDFNSYCRPVXUJJBQLKATZMWFYHGRNDBOEVQPSKJCXUZMRLHNFWBIOASYPUGTQKJNVLZREOXCBYWFTI
GMSPKUAHQJLVROECZNDXWYSUTBOQAPIGMFELNCJVURZKWHXSXTDYFPAUZIOVQGSJXCWMTLEXNBRHAYPIZCMGDOKFXUSQWLJTNVBAREHOQ
ZIDKMCUYYJPWNVBLGSLFHXNEMORQKUIBDYVJAXTSVQPCLUIGRYBHNETMKPZSOJVBWCIDQXULRAYFMOZKNSTPJWCHIGQELVYRBATWFMDOU
CJPSEINKQGYZBVLHFOMRTDNWXSKAJCUYREBPZOIMGSTLAWXVFKHQOZINRPJDMGKCELTSWBYAHNVFEXUOIJRQMAWXTDCPVSBFMKUONWZ
AYLTGKJREBIQMOCYHUPZSDNVXQFAWIKGTELMOJRSUNBZDPQYHOWAFVXMGUEUSKIJPRZDNYLMQHABGXSOUCWETKPVFOINCOYBAWDMZRTJ
HGEXPUOKBFMLZQIWRNAYTJVGBDUPCFEHSKXLZOWAGMNRDJDUIBQTFVSKARWPCOUNHMBYGXZJQLEWIFOCVAKTUPXMRNJTGDZQYBAWSE
CVOPLUJWPYONUTSDIKGCPAHXRUEJOMBNDZWLTYCSPARVOMFBEUQNIDJKWHYSGLOXCPAHBTMUSKRQVDZNJOFGIEWXRLCSOPTUBKQMNHJ
VGIRESAWDLFYQCXOMKPUNBJRHGSFTZEQVYADJOWMSPUBNGKIROFLHCTAQXEWJZNDMSVGOPUFYBEKWJQLRICZXHDNPAUSOGMFKBETCJWY
QDVRHNZLXIPIUOASGBMKETFQYJWCZNOPAXHRMDUGSELYIBCQVTJKWFMDNUZQROPJYHXAEGSLVCIWTKMFKPUDQOYZBXNRJCSLMEGKAFIPTBNU

LRQXQWYHDJZOMVQCEALWPRUKNFYTSGBXHJIMOQVALNZNRDGEWKPTYUFCXSABQLWJOMNGKVREDEZSHQYPTFBUANIXWXC SQOQREJZ
 UFTVBSAIVLNCNJRKGQJHJUEZDHTXMPNRBWEQYMFVONSUVRGCRJQKEPAZOHBTSXWNGMFYUQKFTBPCILJOZRGTESHBXUNQYAWMPCFDIKR
 TAGBVYPPYNWMKUFDIZSHOJLBTAXCGRNPWEQYMFVONSUVRGCRJQKEPZBLCNRPJWMDGQXVYEUOKSFBRCQHJINWPAZGMKULSXOVEYDFRQK
 ZXCAGPSKEUNLTBMVQHYDICOEFJZEGSRWQKPAUBINXMOYCHRFATLQDJWKEGSPZVMNIBXROYLCTDAQUJKSPMRWNOXHVEBYGZFIQT
 WKMYHJEA LSROZFTVQYUGBAOWNYD JMPIECLSKRFGZUAOHPBTVQXMYNDIJRGLBECOKFSZUAPQTHVNYMIEJRWXOSKCDUBLGQPFZM
 VBUOCEQKARFZPYWYTSNDGJMV LHCBUEQIAOKZRWPYUNXSJMGFCLBETZDKVROAIXPHYBFWQJEMCUNGSLTZKDRQYVBAXFMCELJZ
 HLCPEZJTYQAIPOMNCLEWUJYVSBETGRKZUOAAMHPWFIHQSDXCTBGJKYVLQROPJAEUWMBZBXHCNLYQS OVIPGBETJKJWDURMAFCIZNOH
 DLBKVRJZUNGMXOIRQFSYAZKLHRWBUMVEXCJDAOIPNTZBLUSQGCYHMKFRVWEGXAPQSCJMNULTYDKIBHVFOQEWRMACXNPSYVG
 BHCIKLMOXDNAYPFSWQVTMBGJZUOEDLINASKPYXRQCGMOZWYLVXFTJNBUDCSKHERPAOQZTGMNIWFSJVLXUYAPHCBRTEWOQKMFZ
 RILSAPQHBZVKMTGEOWIDFNSYCRPVXUJBQLKATZMWFYHGRNDIBOEVPQSKJXCZUMRLHNFBWIOSAYDPUGTKJNVLRZEOXCHBYWTF
 QJLVROECZNDXWYSUTBOQAPIGMFLNCJVRJZKXWSXBTDYFPAUZI OVQGSJCWMTE LEXNBRHAYIPZCMGDKFXUSQWLJTNVAREHOQZ
 JPWNVBGLSFHXNEMORQKUIBDYJWJAXTSVQPC LZUGRBYBHNETMKPZSOJVBWCIDQXULRAYFMOZKNSTPJWCHIGQELVYRBATWFMDOUC
 GYZBVLHFOMRTDNWXSKAJCUYREBPZOIMGSTLAWVFKHQZOINRPJDMGKCELTZSWBYAHNVPEXUOJRMQAWXTDCPVSBFMKUONWZA
 BIQMOCYHUPZSDNWXQFAWIKGTLMOJRSNBZDPQYHWAFAVXMGUECSKJPRTZDNYLHMHABGXSOCUWETKPFVOCINQYBAWMDZJRJT
 BFMLZQIWRNAYTJVBGDUPCFEHSKXLZOWAGMNRDYJUIBQTFVSKARWPCCOUNHMBYGXZJDQLEWIFOCVAKTUPXMRNJTDGZQYBAWSE
 ZQBPEDNWLVTGJKYVJXIAHMFCEYSRMGKJQIPADZUHOWBTFQVLEGPSCZRNLTQIMIDYVWBOAFLHXJESKNRCRPTZUOGAMYDHFHQE
 WZRPNTAGIYUMKDFJBJHQVLCENSPAGWOYGIUFMTXHBKDQARJFVSEOPCOHBTXSWNGMFYUQKFTBPCILJOZRGTESHBXUNQYAWMPCF
 CLJUXTAGBQVPYNNWMKUFDIZSHOJLBTAXCGRNPWEQYMFVONSUVAIZBLCNRPJWMDGQXVYEUOKSFTBRCQHJINWPAZGMKULSXOVEYDF
 WJWJZCXGAPSKUEUNLTBMVQHYDICOEFJZEGSRWQKPAUBINXMOYCHRFATLQDJWKEGSPZVMNIBXROYLCTDAQUJKSPMRWNOXHVEBYG
 NXUPWKMYHJEA LSROZFTVQYUGBAOWNYD JMPIECLSKRFGZUAOHPBTVQXMYNDIJRGLBECOKFSZUAPQTHVNYMIEJRWXOSKCDUBLG
 TNHSVBUCOQEKARFZPYWYTSNDGJMV LHCBUEQIAOKZRWPYUNXSJMGFCLBETZDKVROAIXPHYBFWQJEMCUNGSLTZKDRQYVBAXFMCEL
 WSTHBVKRZDXUYQAIPOMNCLEWUJYVSBETGRKZUOAAMHPWFIHQSDXCTBGJKYVLQROPJAEUWMBZBXHCNLYQS OVIPGBETJKJWDURMAFCIZNO
 AVBDLKCPEJUTGNMXOIRQFSYAZKLHRWBUMVEXCJDAOIPNTZBLUSQGCYHMKFRVWEGXAPQSCJMNULTYDKIBHVFOQEWRMACXNPSY
 TRUBHCIKLMOXDNAYPFSWQVTMBGJZUOEDLINASKPYXRQCGMOZWYLVXFTJNBUDCSKHERPAOQZTGMNIWFSJVLXUYAPHCBRTEWOQK
 XNJRILSAPQHBZVKMTGEOWIDFNSYCRPVXUJBQLKATZMWFYHGRNDIBOEVPQSKJXCZUMRLHNFBWIOSAYDPUGTKJNVLRZEOXCHBYW
 UHJQLVROECZNDXWYSUTBOQAPIGMFLNCJVRJZKXWSXBTDYFPAUZI OVQGSJCWMTE LEXNBRHAYIPZCMGDKFXUSQWLJTNVAREH
 UYTPJPNVBLGSLFHXNEMORQKUIBDYJWJAXTSVQPC LZUGRBYBHNETMKPZSOJVBWCIDQXULRAYFMOZKNSTPJWCHIGQELVYRBATWFMDOUC
 NKTQGYZBVLHFOMRTDNWXSKAJCUYREBPZOIMGSTLAWVFKHQZOINRPJDMGKCELTZSWBYAHNVPEXUOJRMQAWXTDCPVSBFMKUON
 JREBIJMOCYHUPZSDNWXQFAWIKGTLMOJRSNBZDPQYHWAFAVXMGUECSKJPRTZDNYLHMHABGXSOCUWETKPFVOCINQYBAWMDZJR
 UOQBFLMLZQIWRNAYTJVBGDUPCFEHSKXLZOWAGMNRDYJUIBQTFVSKARWPCCOUNHMBYGXZJDQLEWIFOCVAKTUPXMRNJTDGZQYBAG
 ADZQTKRXYWJPHNCSGOFAMIVBUDNJTKTEQPOYMRWAZLCSNHIFBVGXVQKUEOTNDSAWMZRJCPHYFLGCSQIBOVKUAMDZJRLDZQYPCJW
 YMKUEBOAZDFSRCNPQIWLGHXTYBVBKSAMEORUQWNCZIDYFPXBLHTAGSJOJMWQCRWYUEPIBNDPASFZLJYTRQGCVXVUHMEOSNIDE
 AJYGLZSWURNOVEIDBHMHQXACYOWLSNGPTZEFURIJOMVODBNVWYKPSQZTIBELXFAOHJYKVMCSDPTZUBNGEOQAWRYLJTJFKKM
 GTNOELIWRQYMFHLKLACBXCJOSPEGVRYITXMXZCWFJNKDSALQAGMYTOUBWEKFRCPXVZJSTNIOYHABGLQJXUWMKDPJFVCRZISOTQ
 HKLJPVMCWZEURISTNYHAKMDBCUPVLVJQZGXEWIOIMBRTANYXUCQLGJKVEZODHSPWBFMTIQRAYNCUKJOGXVSDHWIBFETPMRUZOK
 QJLSDQUMWMEKORCPFTZHBNLYSYWQJKAODPTCEPFMFNXYUWYHBTLOJQCKDJAOHUEFWSRYZXCSTOBNKL GAMVDJEURIWFTJ
 GANDMIHVKDFURJPMZETVPOXNLCAISKJLGMHJRQEDUFWPVZOTCMXBUNQJIASRGKYOHLEFSTPTVUAZXDPSOGRQYINXMHMBEJFCRZTJNU
 MKBRGXQXCHYJWNLFXEATGOPSZDMIVRQUKNWLCXYOEJBIFSHTZMQODNRVPGUWCYIBXKLASEMFOJQTNZGCWHYVXAUDOPKERNQMF
 COHJPGVRAMFBUHQDYXENOKCSLWJNZPFHAUTBGYQVXEOSKMDNCIBJHAPZVRUYMOXLQVEGFTNSKNURJJOAIZPCYMBDGHQELTFLVW
 SCRPIYMETOGQXHAUVZWNKPCDSBROQXAYTIUMLZJFGHVEKAWPTNRNCSMOCBJTRJGYZADUKFNPELWOMHSCXBJXIAZTJYVOKSUM
 SQHBRNOJZPISATUMEODCGFWQKLYXBHNSVRJTPIZOEUAJBCLQMGRYKWPNFVISYDABTCQNJOZHXGKUMRLVYEFYTCWINSNGTDBPAH
 KQWUCLNBSIGFTQAWHYPMUZZKXOJRDNVSLEGLMBFTAOYZQPQKHRCVUNGSJKEIDBXMNZTCOWFRLJULVKVQSPGAMDEIUCOXZHTJW
 SFYKRGREIAOJZCHXWSDMSYVNULOJRKPEKITGUJZYXSWBCMDARQFKHNLMLVBTIYVWEGXSPJQKAUOZFNRDLCHVMBICPDYNSJKURGT
 XYFBWTNGOIPCSAMKJURQELDRVYNXBKFTGZOOMQIESAHWLPDJXCRMVNBOSYFUZKWATGPQHILXONJBERMVNQSUOKFWYHIROTACPZ
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 LASOGMFKBTKJWJYQDVRXNZHLXIPUOASGBMKEFTJYWCNZNOXPAXHMDUGSEL YBICQPTJKWFMDNUJRNJYHXAEGSLVCIWMTKQFQJ
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SWBYAHNVPEXUOIJRQMAWXTDCPVSBFMKUONWZAYLTGKJREBIQMOCYHUPZSDNVXQFAWIKGTLMOJRUSNBZDPQYHOWAFVXMGUEUSKJIPRTZDNYLMQHABGXSOCUWETKPVFOINCQYBAWDMZRTJTHGESXPQOKBFMLZQIWRNAYTJVBGDUPCFEHSKXLZOWAGMNNRYDJUIBQTFVSKARWPCOUNHMBYGXZJDQLEWIFOCVSAKTUPXMRNJTDGZQYBAWSECVOLURCSZBPEDNWLYGTKJOVXIAHMFUQCSEYRMRKNGLXPADZHUWBTFTQVLGEPCCSRNTQUMIDYVWBOAFLHJXESKNCRPWZTUOGAMDYIFHQBXLVJECSSOWZRPNTAGIYUMKDFJBHQXVLCENRSAPWGOYIFUMZTHBKDQARJXEYSOFPCGWMYLVNBIADZQTKRXYEYWPJPHCSGOFAMIVBUDNQJTKPEOYMRWAZLCSNHFHXBGYVUKUOTNDSAWMZRCJPHYFLGXQIBOVKUEMDAQZRLNTYPCJWSBGHOFIVYQZTMGNIWFSJVLXUYAPHCBRTTEWQKMFZGDCUYXNJRLSAPQHBZVKMTGEOWIDFNASYCRPVOXUJBQLKATZMWFYHGRNDIBOE
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HGESXPQKBFMLQZQWRNAYTJVGDBUDCFEHSKLZOWAGMNRVDJUIBQTFVSKARWPCOUNHMBYGXZJQLEWIFOCSSVAKTUPXMRNJTDGZQYBAWSE
CVOPLURCSQZBPDENWLYGTJKJOVXIAHMFUCQSEYRMKNJGXPADZUHWBTFQVLGEPSCSZRNTQUMIDYVWBOAFGLHJXESKNCRPWZTUOGAMDYIFH
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VMEXCJDAOIPTNZBLUSQGCYHMKFRVWEGXAQPOSCJMNULTYDKIBHZVFOQWRMACNXPFSVGZQJQFRTHBCHIKLMOXDNPYPSFWQVTMBGJZUOED
LINASKPYXRQCGMOZWYLVXFTJNBUDCSKHERPAOQZTGMNMFWSJVXLUYAPHCBRTIEWOQKMFZGDCUYXNJRILSAPQHBZVKMTGEOWIDFNSYCRPVX
UJBQLKATZMWFTYFPAUZIOWQVQSKJXUZMLRHNHFWBIOASYPDUGTQXJNLZREOXCBYWFITGMSPKUAHQJLVROECZNDXWYSUTBOQAIGMFELNC
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VQPCLUIGRYBHNEMTKPZSOJBVCWDQXULRAYFMOZKNSTPJWCHIGQELVYRBATVFXMDXOUXJPSEINKQGYZBLVHFOMRTDNWXSJKAJUCYREBPZIO
MNSTLAWXVKHQZOINRJDJMGKCELTWSBYAHNVPEXUOIRJQMAWXTDCPVSBFMKUONWZAYLTGKJREBIQMOCYHUZSDNVQFQAWIKGTELMJOUR
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WAGMNRVDJUIBQTFVSKARWPCOUNHMBYGXZJQLEWIFOCSSVAKTUPXMRNJTDGZQYBAKDFJBHGXVLNENRSAPWGOYIFUMZTHBKDQARJXEYSOFF
CGWMLVNUBIADZQTKRXYEYJFSCSGQFAMIVBUDNQJTKSEPMYRWAZLCSNHFHXBGVQVKEJTOJMSQWZJPCPHYFLGXQIBOVKUEMAZXQLRNTPCY
JWSBGHOFIVYMKUEBOAZDFSRNCPQJWLXGHTYBKSAEMOORQWNZCIDYFPXBLHGTAGSOMJQVCRWYUEIPBNDOFASZKLJYTPJRGCVWYUHMES
NIDBPFQXTMACJYKLSZUWNOVEIDBMHQXACYOWLNSGKTPZEFURIQJMVDDBNWYKGPSQCTIZELURFAOHHYKVMCSDDZUBXNGEIOQAWRYLJTF
KXMCVZSBDAPGNTONEIRWQYMFUHLKAXCBJOSQPEGVRYITXMCZUWOFJNKNTALXUQCGJKEVEDEKDFSWPFXVZJSITRNUYHABLGQXSWMDHBEJFCVRZU
OTQNYBFGAHLKLPVMCEYUORISTNYHAKMBDQPVLFJQZGXEWOIMBKTANYSALQCLGJKEVEDEKDFSWPFXVZJSITRNUYHABLGQXSWMDHBEJFCVRZU
ZOKLVQCNQYXAGJISDBQWWMKEORCPFZTHBNVLSYUWGLKADQDTCERPMFKNYSVWUUBHTLOJGCKDJAMEVFSWRYZXPHTOBKNLCGAMVDQJEURW
FTZXSCQYBPGQALNMHHKVDUFJRJWMLZETWPOXNBSAISRYLGMHJRQEDUFWPVZOTCMBXNJIJASRGQYOHWFETPVUAZDCSOGQRYHNMHMLBEFWCJ
TNUDPYZISAOQMBRGXQHCYJNNLXEATGPOSDZMIVRQKUNLXCXYOEJIFASHTJQZQDNVRPGWUICYXBLKASESMQJQTNZGCGWHYVXADOPKERN
QKFBFSLYJZTBOHJPGVIRAMFUGBKQYEXNOICSLWJNZPFAHTBGVJQRXOESKMDNCBIBJAPZWJRMYMOXLQVEGFTNSKURWJOAIZPCYMBDQHEQTL
VFMWXSOKUZJBSCORQWGHQXHAUVZWNKPCSDSBRQOXYATIUMLJZGFHAEKAWPTRNQSXMOCBJITRQJZVADUKFNEPLOWHMSQCXBZJIATRYVOKS
FULMEWCPXDGQBHRNOJZPISATUEODCGFWQKLZYBYHNSVTRJPIZEOEXABCLQMGYRKYPWNFVJSDYBATCQJNOJZXHGKUMMLPVYEFTWCINSZTDZBP
AHMYJXORVEASFQWUCLNBSIGFTQAWHYPMUZZKVOJRDNYSEGLIMBZJYOSWZPHKWXCRVNGJSKDEIBMXNZCTCWFHRJLUQVYKSPGADMEIUCXJXZ
TJWRQVBLNASKFYRNGEITAOJXWDXMSYKVLQBRKEGTGUMJYSWBCZMDQKCHNLMMVYTBIXWEGNSJQKAOUZFNRLDKVYMBICPDYNSCOWUR
GTAWQOELZHXFYFBWNTGNOJPCSAMKUJRQELDRVYNXBFKTGZUUMQIESAHLWLDJXCRMVNBNOYSFUZKWATGPQHILXONJBERMVNSUDKFVYHIROTA
CPZBLTQUGLEAVUNMKDSWOAIRQLZTECGNMXSHYJPFBKVEZTOQWLAIXTCYHJMNOGCVBFQSKWUZEPJVMCONRALTJGDQXVZSTMIWNVORHKAECYB
GDJBXLQFQJLAOSMKNVINRYCZTFBEGJUDGMHXSXAWLVYORTNQOALBPRJEASMKWQGDUIRYOTXBNJZCHGAKVMSDQWYFFQRNZJNTDIOUSKXLEFV
GQHYTZADPVONMSUBJEXCIKYRFQWMPAZHNLDOBUSKRTIYJQEWMPNGAXOYFHTLDCSBKWQIXMZPOUEJTAUVYSGHRLKNBFCIZROMUEDGSXYJQ
ALPNVBTBZCMIFHTNYREUGJSXWQFZALHKBDBYVCPMHITORNEQSUGALWMZXTDVBREOHCYJFXPKNSQZLQJALBTHMVQREOJNSZDLFCXKWIYA
GMQPGJOHSVRWNTKLCEZYDOSXWXPVUJMAHFIBTGNMYZEKVLJCRZSPFBGOEDWETAUAMYKICZOSRQJXJFBUAGVNMHWIETQNDYSXOUKZCPLFR
JYMAONTQIXEBYWDSHPLCRUFJAZWMKOTGYNVQBXEDIZSCMRQFTLBPNUVKYOJEGAWXSMRDKIBZYNQUPHCVJEGTOSXFMLWUARNBZDQYOWCSI
JTMEKGFHBXVPAOLZRWIYUQCSWATMFJVRPGYKDNIOUJELTHSCZBAWYNJPRVCOKXQDFEGLSZWBMATUITYPSXOVRCJNDGQKBEFTHMPOWLZUYJ
AVGNSDIBKRWCAOEMFZQLSJBGXGTYTHPOKURMDZNCVEFAXJLOSQYTGPIHWARNMVBZKUUCIOSDXTFCYJLAGIEWIRVPUBKNOSCGJDEZTALFMXQN
WOHISBYCAJAJUGRLRZWTMQIFEXNVCTUDYPSOLZJGBHWRNKIAEMXSTYWOULQBJZDYPVNVNCHQOKTGIBMQSAXWFHLCKNEJVTYOYGZUBSMQIFXR
AWDJKNBOLJLMHCUOTYFZSPGIRWJEAHNXUBOQKWSMDZVTPRGYLCAXUJKBMFQJCNZTSZVHDYOPUVLGRNEJTNKWBHFGSGQKXUHDYJIRPVNMITE
AZCQOBWLSFIKGTCKMAEGZBLVBQHRXJFWPYONUTSDIKGCPAHRUQEJOMBPNFDZWLTYCSPARVOMFBEUQNDJMKWHYSGLGXCPAHTBTPSKRQVDZ
NJOFGIEWXRLCSOPTUBKQMNHJVIGIREZAWDLFYQCCXOMKPUNBJRHGSFTZEQVYADJOXWMSWPUBNGKIROFLHCTAQXEWJZNDMSVGOPUFYBEKWJQI
RICZHXNJAUSOGMFKBETCJWYQDVRHNLXIPUOASGMBKMTFYQJWCNZOPAXHMRMDUGSELQYBZCPTJKWFMNDNUZQROPJYHXAEGSLVCWITMKFPQ
UODYZBXNRJCSLMGKAFIPTBNUSORQXWYHDJZOMVQGCEALWPRUKNFYTSGBXBJIMOQVALNZRDGWEKPTYXUFCSABQLWJOMNGKVRDEZSHQYPT
TFBUANIWCSPQDIKZJKGDHYMPUFTXVBSAAILCONJRGKEUYZDHTMPBAIWFONSLVUGCRJOKEPAZOBHTZWSWNGMFYUQKVPDCLJOZRGJTESBZ
XUNQYAWMPCFQIRKHEOZSLJXTAGBQVPYNMWMKUDFIZSHOJLBTAXCGRNPWEQYVMVFKTOISAIBZLBNRPWMDGQXVYEUOKSTFBRQCINJWPAZG
MKULSXOVEYDFROQBHTNMWJJCZGAPSKUENLTBMVQHIDYCOFJZEGSRWQKPAUINXMOYCHRFATLQDJWKEGSPZVMNIBXROYLFTDAQUJKSPM
RWNOXHVEBYGZFIQTBCDNXPUPWKMYHJALSROZFTYXUGBAOWNYDJBMPIECLSKRFGZUAOHPBTQXMMWYNDJRGLEBCKOFSZUAQPTTHVNMIEJW
RXOSKCDUBLGQGPZFMFYWJTNHVSBUOCEQARZFZXVYTDNGBJMVLHCUBQEAIOAKZRWPYUNXSJMGFCLBETZDKVROAIXPHYBFWQJEMCUNGSOALTZK
DRQYVBAXFMCELIJUGNPOWSTHBVKRZDXQQAIPOMNCLWFUJVSXBETGRKZUOAMHPWFIENQSDZBGJKYVLQROPUEAWMBZXHCLNYQSOVIGBETJ
KWDUXRMAFCINZHOSSQYVAVBDLKCPEJUTGNMJOIRQFSYAZKLHRWBVMEXCJDAOIPTNZBLUSQGCYHMKFRVWEGXAQPOSCJMNULTYDKIBHZVFO
QEWRMACQXNPSYZGZQYJQFRUABHCHIKLMOXDNPYPSFWQVTMBGJZUOEDLINASKPYXRQCGMOZWYLVXFTJNBUDCSKHERPAOQZTGMNMFWSJVXLUYA
PHCBRTIEWOQKMFZGDCUYXNJRILSAPQHBZVKMTGEOWIDFNSYCRPVXUJBQLKATZMWFTYFPAUZIOWQVQSKJXUZMLRHNHFWBIOASYPDUGTQKJ
NVLZREOXCBYWFITGMSPKUAHQJLVROECZNDXWYSUTBOQAIGMFELNCJVURZKWHXSXBTDYFPAUZIOWQVQSKJJCWMTLEXNBRHAYPZCMGDOKFUS
QWLJTNVBAREHOQZIDKMCUJTPJWNVBLEGSFHXNEMORQKUBDYJAXTSVQPCLUIGRYBHNEMTKPZSOJBVCWDQXULRAYFMOZKNSTPJWCHIGQEL
VYRBATVFXMDXOUXJPSEINKQGYZBLVHFOMRTDNWXSJKAJUCYREBPZIOIMGSTLAWXVKHQZOINRJDJMGKCELTWSBYAHNVPEXUOIRJQMAWXTD
CPVSBFMKUONWZAYLTGKJREBIQMOCYHUZSDNVQFQAWIKGTELMJOURSBNBZPDQYHWOAFVXMGUECSKJIPRTZDNYMLQHABGSOCUWETKPVFOI
NCQYBAWMDZJTBHGESXPQKBFMLQZQWRNAYTJVGDBUDCFEHSKLZOWAGMNRVDJUIBQTFVSKARWPCOUNHMBYGXZJQLEWIFOCSSVAKTUPXMR
RNJTDGZQYBAWSECVOPULURCSQZBPDENWLYGTJKJOVXIAHMFUCQSEYRMKNJGXPADZUHWBTFQVLGEPSCSZRNTQUMIDYVWBOAFGLHJXES

KSAMEORUQWNZCIDYFPFXBHLKTAGSJOMVQCRWYEUPIBDNOFASZKLJYTQRGCWXVUHMESONIDBPFXXQTMCAJYGLKSKZWURNOVEIDBMHQXACYOW
LNSGKTZPEFURIQJMKVODBNWYKGPSQCTIZELURXFAOHJYKVMCSDDTPZUBNGEIQAWRYLJTFKXMCVZSBDAPGTNOEIWRQYMFHLUKAXCBJSOSQPEG
VRYITXNZUCWOFFJNKDSALQAGMYTOUBWEKFRCPXVZJSITNOYHABGLQXUJWMKDPJFVCRZISOTQNYBFXGAHKLJPVMCWZEUORISTNYHAKMDBCUP
VLFJQZGXEWIMBRTANYUXCQLGJKVEZODHSWPBFMTIQRAYNCUKJOGVXSDHMBIFETPMRUZOKLVCQNYXAGJISDBQUWMKEORCPFTZHBNVLSYIW
UGJKAODQTCPERMFKNZYWVUHBTOLIGQCKDJAMEUFWSRYZXPHTOBKNLGCAMVDQJEURIWFTZXSOCYPBQGALNMHKKVDFURJYKMETZWPXNCBAI
SKYLGMHJRQEDUFVPVZOTCMBXNQIJASRGKYOHLWFETPVUAZXDSCOGQRIYNKMHMBEFWCJTNUDPVZISAOMKBRGXQHCHYJWNLFXEATGOPSDDZMI
VRQUNWLCXYOEJBIFSAHTZMQODNRVPGUWCYXBLKASEMFOJQTNZGCVHYYXAUDOPKERNQMFBSYLVWIZTCOHJPGVRAMFUBKDQYEXNOICSLWJ
NZPFHAUTBGVYQRXEOSKMDNCIBJHAPZWRUYMOXLQEVGFTNSKWRJJOAIZPCYMBDGHQETLVFWNXOKUJBSRCRPIYMETOGGXHAUVZWNKCPDSB
ROQXAYTIUMLJZFGHVEKAWPTRNQSMOCBJTIRGYZVADUKFNPELOWMHSQCXBZJIATRYVOKSFUMLEWCPXGDGQHBRONJZPISATUMEODCGFWQKL
XYBHNSVRJTPIZOEUAHBCQLQMGYRKWPNFVYSYDABTCQNJJOZXHGKUMRLPVYEFTWCINSGTDZBPAHMYJXORVEKQWUCNLBISGFTQAWHYPMUZCKXO
JRDNVSEGLIMBFTOAYZQPHKWXCRVUNGJSKDEIBMXNZTOCWRFRHJLJULQVXSPGADMEIUCOXZHTJWRQBVNLASFPPYKRGEITAOJZHCWDXDMSYVNUZ
BRKEPITGUZJYXSWBCMDAROQFKHNLMVYBTIWXEGPSJQKAUOZFNRDLCHVMBCIPDYNJSJWKURGTAVOQLEZHXFYBWTNGOIPCSAMKUJRQELDRVYN
XBFKTGZOUMQIESAHLWPDJXCRMVNBOYSFUZKWATGPQHILXONJBERMVNQSUOKFWYHIROTACPZBLQGJEVUNMKDSWOAIRQLZTECGNXUMHSYJ
PFBKVEDTOQLWLAXITCYHJMJNNOGBVBFQSKWUZEPDYMCONRTALGJXUPZSTMIWNVORHKAECYBGDJXPTUFQLAOSMMWKINRYCZTFBEQJPDUGHMSX
AWLVIYORTNCQKFBPJASMKWGDUIYRTOXBNJZCHGAKVMLSDEWYFPQRNZIBCTUOSKXLEFWGQHYTZADPVONMSUBJEXCIKRYFQWMPAZHNLDO
BVUSKRTIYJQEWMCNPGAXOYFHTLDCSBKWQXIMZPOUEJTAVYSGSHRLKBNFBCIZROMUEDGSXYJQALPNVBTKWZCMIFHTNYREUGJSXWQFZALKODBV
YCPMHITORNQESUGALWMZXDTVBYREOCHJFXPKNSQZWUIALGTBHMVLRNASKQJSDNZLUCFXKWIYAGMQPJOHSVRBTNKLCEZDYOSWXPVUJMQAHFIBT
GNYMZEKWLIIJCRZSPFBOGWETNVDUAMYKICZOSLRQPJXFBUAGVMHWIETQNDYSXOUKZCPLFRJVMAONTQIXEBYWDSHPLCRUFJAZWMKOTGYNV
QBEXDIZSCMRQFTLBPNUVKYOJEGAWXSMRDKIBZYNQUPHVCJEGTOSXFMLWUARNBZDQYOWCSIJTMOHBTXSWNGMFYUQKVPDCILJOZRGTESHBX
UNQYAWMPQCDIKRHEOZSLJUXTAGBQVPYNWMLKUFDIZSHOJLBXTACGRNPWEQYUVMFKTOSAIZBLCNBJPWMDGQXVYEUOKSFTRBCQJHJNJPWAZGM
KULSXOVEYDFROQBHTNMWJCZXGAPSKUNLTVBMQHYDICOJZEGSRWQKPABUINXMOYCHRFATLQDJWKEGSUPZVMNIBXROYLFCTDAQUJKSPMR
WNXXHVEBYGZFIQTBCDNXPWKMYYHJEALESROZFTVQXUGBAOWNYDJMPIECLSKRFGZUHAOPBTVQXMMWYNDIJRGLBECOKFSZUAPQTHVNYMIEJWR
XOSKCDUBLGQPFZFMYYJTNHNSVBUOCEQKARFZPXWYTSNDGJMVNLHUCUBQEAIAOKZRWPYUNSXJMGFCLBETZDKVROAIXPHYBFWQJEMCUNGSLTZKD
RQYVBAXFMCELIJUGNPOWSTHBVKRZDXYQAIPOMNCLWFUJYVSBETGRKZUOAMHPWFNIQSDXCTBGJKYVLQROPUAEWMBZXHCNLYQSOVIPGBETJK
WDUXRMFAFCIZNOHSQYWAABDLKCPJUTGNMXXOIRQFSYAZKLHRWBUBVMEXCJDAOIPNTZBLUSQGCYHMKFRVWEGXAQPOSCJMNULTYDKIBHZVFOQ
EWRMCACTXNPSYZGOJYQFTRUBHCILMOXDNAYPSPFWQVTMGBJZUOEDLINASKPYXRQCGMOZWYLVXFTJNBUDCSKHERPAOQZTGMMNIWFSJVLUYAPHCBRT
HCBRTWOQKMFZGDCUYXNJRLSAPQHBZVKMTGEOWIDFNSYCRPVOXUJBQLKATZMWFWYHGRNDIBOEVPQSKJCXUZMRLHNFWBIOASAYDPUGTQKJN
VLZREOXCBYWFTIGMSPKUAHQJLVROECZNDXWYSUTBOQAPIGMFELNCJVRZKWHXSXTDYFPAUZIOVQGKSJCWMTELEXNBRHAYPIZCMGDOKFUSQWL
WLTJNVBAREHOQZIDKMCUYTJPWNVBGLSFHXXNEMORQKUIBDYWJAXTSVQPCLUIGRYBHNETMKPZSOJBVWCIDQXULRAYFMOZNKSTPJWCHIGQELVYR
BYRBATWFMDOUCJPSEINKQGYZBVLHFOMRTDNWXSKAJCUYREBPZOIMGSTLAWXVFKHQUOZINRPJDMGKCELTWSWBYAHNVFPFEXUOIJRQMAWXTDC
PCVPSBFMKUONWZAYLTGKJREBIQMOCYHUPZSDNVXQFAWIKGTELMOJRSUNBZDPQYHOWAFVXMGUEUSKIJPRTZDNYLMQAHBGXSOCUWETKPVFOI
NCQYBAWDMZRJTHGESYPUOKBFMLZQIWRNAYTJVGBDUPCFEHSKXLZOWAGMNRDYDJIBQETVFSKARWPCOUNHMBYGXZJQLEWIFOCVAKTUPXMRNJTGDZQY
BAEKFBXVPAOLZRWIYUQCSWATMFJVRPGYKDNUIXELTHSCZBAWYNJPRVCOXKQDFEGLSZWBMAUTIYPSXOVRJCJNDGQKBFTFHM
POWXLUZTJAVGNSDIBKWRCAOEMFZQLSJWBGXTYIHPOKURMZDNCVEFAXJLOSITYQGPIHWRNMVZBKUOCSDTXFQYJLAGEWIRVPUKMBNOSOCJDEJZ
TALMFQXNWOHISBYCKAJUPGLRZWTMQUIFEXNCUTDYPSSOLZJGBHWRNKIEMXCFSTYWOULQBJZDYRPNVNCHEOKTGIBMSQXALXJWFTHCLNEJXTVOYDZU
BSMQIXFRAWDJNKOBYLHMCUTQVZFSPGIRWJEAHNXUBOQKWSMDZVTPRGYLCAXUJKMBIFQETNSZWHDYOPUVGLCRNEJTMWABFQSGOKXUHDYJ
IRPVNMTTEAZCQOBWLSFIKG

2. PLAYFAIR Encrypted:

TCMKEAGSLZBVQHRXFJWPYONUTSDIKGCPAHXRUEJOMBNDZWLTYCSPARVOMFBEUQNIDJKWHYSGLQXCPAHBTMUSKRQVDZNJOFGIEWXRLCS
OPTUBKQMNHJVGIREFZAWDLFYQCXOMKPUNBJRHGSFTZEQVYADJOXWMSWPUBNGKIROFLHCTAQXEWJZNDMSVGOPUFYBEKWJQLRICZXHDNPAUSO
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MEGKAFIPTBNUSORQXWYHDJZOMVQGCEALWPRUKNFYTSGBXBJIMOQVALZNRDGWKEKPTYXUFCASBQWLWJOMNGKVRDEZSHQYPTFBUANIWXCISOQ
REJZKGHDYMPUFXTVBSAWILCONJRGKQEUZYDHTMPBAIWWYFONSLUUVGCRJQKEPAZOHBTXSWNGMFYUQKVPDCILJOZRGTESHBXUNQYAWMPCFDI
KRHEOZSLJUXTAGBQVPYNWMLKUFDIZSHOJLBXTACGRNPWEQYUVMFKTOSAIZBLCNBJPWMDGQXVYEUOKSFTRBCQJHJNJPWAZGMKULSXOVEYDFR
OQBHTNMWJCZXGAPSKUNLTVBMQHYDICOJZEGSRWQKPABUINXMOYCHRFATLQDJWKEGSUPZVMNIBXROYLFCTDAQUJKSPMRWNXXHVEBYGZFI
QTBCDNXPWKMYYHJEALESROZFTVQXUGBAOWNYDJMPIECLSKRFGZUHAOPBTVQXMMWYNDIJRGLBECOKFSZUAPQTHVNYMIEJWRXOSKCDUBLGQPFZ
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UGNPOWSTHBVKRZDXYQAIPOMNCLWFUJYVSBETGRKZUOAMHPWFNIQSDXCTBGJKYVLQROPUAEWMBZXHCNLYQSOVIPGBETJKWDUXRMFAFCIZNO
HSQYWAABDLKCPJUTGNMXXOIRQFSYAZKLHRWBUBVMEXCJDAOIPNTZBLUSQGCYHMKFRVWEGXAQPOSCJMNULTYDKIBHZVFOQEWRMCACTXNPSYZG
OJVFQTRUBHHCILMOXDNAYPSPFWQVTMGBJZUOEDLINASKPYXRQCGMOZWYLVXFTJNBUDCSKHERPAOQZTGMMNIWFSJVLUYAPHCBRTWOQKMFZ
GDCUYXNJRLSAPQHBZVKMTGEOWIDFNSYCRPVOXUJBQLKATZMWFWYHGRNDIBOEVPQSKJCXUZMRLHNFWBIOASAYDPUGTQKJNVLZREOXCBYWFTI
GMSPKUAHQJLVROECZNDXWYSUTBOQAPIGMFELNCJVRZKWHXSXTDYFPAUZIOVQGKSJCWMTELEXNBRHAYPIZCMGDOKFUSQWLJTNVBAREHOQ
ZIDKMCUYTJPWNVBGLSFHXXNEMORQKUIBDYWJAXTSVQPCLUIGRYBHNETMKPZSOJBVWCIDQXULRAYFMOZNKSTPJWCHIGQELVYRBTWFMDOUCJ
CJPSEINKQGYZBVLHFOMRTDNWXSKAJCUYREBPZOIMGSTLAWXVFKHQUOZINRPJDMGKCELTWSWBYAHNVFPFEXUOIJRQMAWXTDCPVPSBFMKUONWZ
AYLTGKJREBIQMOCYHUPZSDNVXQFAWIKGTELMOJRSUNBZDPQYHOWAFVXMGUEUSKIJPRTZDNYLMQAHBGXSOCUWETKPVFOINCQYBAWDMZRJT
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VGIREFZAWDLFYQCXOMKPUNBJRHGSFTZEQVYADJOXWMSWPUBNGKIROFLHCTAQXEWJZNDMSVGOPUFYBEKWJQLRICZXHDNPAUSOGMFKBETCJWY
QDVRHNZLXIPUOASGBMKETFQYJWCZNOPAXHRMDUGSELYIBCVQTKJWFMDNUZQROPJYHXAEGSLVCIWMTKFQPDUDYZBXNKJCSLMEGKAFIPTBNU
SORQXWYHDJZOMVQGCEALWPRUKNFYTSGBXBJIMOQVALZNRDGWKEKPTYXUFCASBQWLWJOMNGKVRDEZSHQYPTFBUANIWXCISOQREJZKGHDYMP
UFXTVBSAWILCONJRGKQEUZYDHTMPBAIWWYFONSLUUVGCRJQKEPAZOHBTXSWNGMFYUQKVPDCILJOZRGTESHBXUNQYAWMPCFDIKRHEOZSLJUX
TAGBQVPYNWNSVBUOCEQKARFZPXWYTSNDGJMVNLHUCUBQEAIAOKZRWPYUNSXJMGFCLBETZDKVROAIXPHYBFWQJEMCUNGSLTZKDRQYVBAXFMCELIJ
ZXGAPSKUNLTVBMQHYDICOJZEGSRWQKPABUINXMOYCHRFATLQDJWKEGSUPZVMNIBXROYLFCTDAQUJKSPMRWNXXHVEBYGZFIQTBCDNXPW
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HBVKRZDXYQAIPOMNCLWFUJYVSBETGRKZUOAMHPWFNIQSDXCTBGJKYVLQROPUAEWMBZXHCNLYQSOVIPGBETJKWDUXRMFAFCIZNOHSQYWAAB
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BHICILMOXDNAYPSPFWQVTMGBJZUOEDLINASKPYXRQCGMOZWYLVXFTJNBUDCSKHERPAOQZTGMMNIWFSJVLUYAPHCBRTWOQKMFZGDCUYXNJ
RLSAPQHBZVKMTGEOWIDFNSYCRPVOXUJBQLKATZMWFWYHGRNDIBOEVPQSKJCXUZMRLHNFWBIOASAYDPUGTQKJNVLZREOXCBYWFTIGMSPKUAH
QJLVROECZNDXWYSUTBOQAPIGMFELNCJVRZKWHXSXTDYFPAUZIOVQGKSJCWMTELEXNBRHAYPIZCMGDOKFUSQWLJTNVBAREHOQZIDKMCUYT
JPWNVBGLSFHXXNEMORQKUIBDYWJAXTSVQPCLUIGRYBHNETMKPZSOJBVWCIDQXULRAYFMOZNKSTPJWCHIGQELVYRBTWFMDOUCJVPSEINKQ
GYZBVLHFOMRTDNWXSKAJCUYREBPZOIMGSTLAWXVFKHQUOZINRPJDMGKCELTWSWBYAHNVFPFEXUOIJRQMAWXTDCPVPSBFMKUONWZAYLTGKJRE

BIQMOCYHUPZSDNVXQFAWIKGTELMOJRUSNBZDPQYHOWAFVXMGEUCSJKIPRTZDNYLMQHABGXSOCUWETKPVFOINCQYBAWDMZJRJTHGESXPUCOK
BFMLZQYIWRNAYTJVGBDUPCFEHSKXLZOWAGMNNRYDJUIBQTFVSKARWPCOUNHMBYGXZJDQLEWIFOCVSAKTUPXMRNJTDGZQYBAWSECVOPLURCS
QZBPEDNWLGYGTKJOVXIAHMFUQCSEYRMKNGIJPADZUHOWBTTFQVLGEPCCSZRNTQMIDYVWBOAFGLHJXESKNCRPWZTUOGAMDYFIHQBLXVJECSCO
WZRPTNAGIYQVMMKDFJBHQVLGCENRSAPWGOYIFUMZTHBKDQARJXEYISOFFCNRHBTXSWNGMFYUQKVPDCILJOZRGTESHBXUNQYAWMPCFDIKRHEOZ
SLJXTAGBQYUWPNKMUFDIZSHOJLBXTACGRNPWEQUYMFVKTOSAIZBLCNRJJPWMDGQXVYEUKOSFTBRCQHJNWPAGMKULSXOVEYDFROQBHTN
MWJJCZGAPSKUEUNLTBVMQHYDICOJZEGSRWQKPABUINXMOYCHRFATLQDJWKEGSUPZVMNIBXROYLFCCTDAQUJKSPMRWNOXHVEBYGZFIQTBCD
NXUPWKMYYHJEALESROZFTVQXUGBAOWNNDJMPIECLSKRFZGUHAOPBTVQXMWYNDIJRGLBECOKFSZUAPQTHVNYMIEJWRXOSKCDUBLGQPZFMYYWJ
TNHSVBUEOCEQKARFZPXWYTSNDGJMVHLHCBUEIAOKZRWPYUNXSJMGFCLBETZDKVROAIXPHYBFWQJMCUNGSOLTZKDRQYVBAXFMCLELJUGNPO
WSTHBVKRZDXYPQAIPOMNCLWFUJYVYSBETGRKZUOAMHPWFNIQSDXCTBGJKYVYLQROPUEAWMBZXHCNLYQSOVIPGBETJKWDUXRMAFCIZNOHSQY
AVBDLKCEJUTGNMXOIRQFSYAZKLHRWBUVMEXCJDAOIPNTZBLUSQGCYHMKFRVWEGXAQPOSCJMNULTYDKIBHZVFOQEWARMACXNPSYZGOJVFQ
TRUBHCIKLMOXDNAYPFSWQVMTGBJZUOEDLINASKPYRQCGMOBNZYLYVXFTJNBUDCSKHERRPAOQZTGMNIWFSJVLXUYAPHCBRTIEWOQKMFZGDCUY
XNJRLSAPQHBZVKMTGEOWIDFNSYCRPVOXUJBQLKATZMWYFHGRNDIBOEVPQSKJCXUZMRLHNFWBIOASAYDPUGTQKJNVLZREOXCBYWFTIGMSPK
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UYTJPWNVWGLSFHXNEMORQKUIBDYWJAXTSVQPCLEZUIGRYBHNWETMKPZSOJBWBCIDQXULRAYFMOZKNSTPJWCHIGQELVYRBATWFMDFMD
NKQGYZBVLHFOMRTDNWXSJAJCUIYREBPZIOIMGSTLAWXVFKHQUOZINRPJDMGKCELTWSWBYAHNVPEFEXUOIJRQMAWXTDCPVSFBFMKUONWZAYLTGK
JREBIQMOCYHUPZSDNVXQFAWIKGTELMOJRUSNBZDPQYHOWAFVXMGEUCSJKIPRTZDNYLMQHABGXSOCUWETKPVFOINCQYBAWDMZJRJTHGESXP
UOKFBQWUMKEORCPTFZHBVNLZYIWWGJKAODQTCPERMFXNZYUWQBTLQZEDQJAMEUFWSWRYZXPHTOBKNLGCAMVDQJKEURWIFZTXSOCVYB
ADZQTKRXYEYJPHCSGOFAMIVBUDNQJTKPEOYMRWAZLCSNHIFXBGYQVUKEOTNDSAWMZRJCPHYFLGXQIBOVKUEMDAZQRLNTYPCJWSBGHOFIVX
YMKUEBOAZDFSRCNPQIWLJGXHTYBVKSAMEORUQWNZCIDYFPXBLHKTAGSJOMVQCRWYEUPIBNDNOFASZKLJYQRCQXWVUHMESONIDBPFQXTMC
AJYGLKSLBZURNNOVEIDBMHQXACYOWLNSGKTPZEFURIQJMVODBNZYLYVXFTJNBUDCSKHERRPAOQZTGMNIWFSJVLXUYAPHCBRTIEWOQKMFZGDCUY
GTNOEIWRQYMFHLUKACXBJOSQPEGVRYITXMZUCWOFJNKDSALQAGMYTOUBWEKFRCPXVZJSITNOYHABGLQXUWMKDPEJFVCRZISOTQNYBFXGA
HKLJPVWCWZEUORISTNYHAKMDBCUPVLVJQZGXEWIOMBRTANYUXXBLGJKVEZODHSPWBFMTIQRAYNCUKJOGVXSDHWIBFETPMRUZOKLVQCQNYXA
GJISDBQUWMMKEORCPTFZHBVNLZYIWWGJKAODQTCPERMFXNZYUWQBTLQZEDQJAMEUFWSWRYZXPHTOBKNLGCAMVDQJKEURWIFZTXSOCVYB
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COHJPGVVRAMFBLKQDQYEXNOICSLWJNZPFHAUTBQYVORXEOSEKMDNCBQJNRYUOYMOXLQEVGFTNSKURWURJAOQAEIUCOXZHTJWRQBVNLNA
SCRPYIMETOGQXHAUVZWKNCPDSBROQXAYTIUMLJZFGHVEKAWPTRNQXSXMOCBJTIRGYZVADUKFNPELOWMHSQCBXZJIATRYVOKSFUMLEWCPXD
GQHBURNOZJSPISATUEODCGFWQLXYBHNSVRJTPIZOEUAJBCLQMGRYKWPNFVISYDABTCQNJOZXHGKUMRLPVVEFTWCINSGZDBZPAHMYJXORVE
AJYGLKSLBISGFTQAWHYPMUZCCKXOJRDNVSEGLIMBFTOAYZQPKHVMXJNRYUOYMOXLQEVGFTNSKURWURJAOQAEIUCOXZHTJWRQBVNLNA
SFPYKRGITAJOZHCXWDMXSYVNUQLBQRKEPITGUZJYXSWBCMDAROQFKHNLMMVYBTIWXEGPSJQKAUOZFNRDLCHVMBCIPDYNJSJWKURGTAVOQLEZH
XYFBWTNGOIPCSAMKUJRQELDRVYNXBFTKGZOOMQIESAHWLPDJXCRMVNBBOYSFUZKWATGPQHILXONJBERMVNQSUOKFWYHIROTCAPZBLQGGJEV
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CMIFHTNRYREUGJSXWQZFALKODBVYCPMHITORNQCESUGALWMXZDVTYBREOCHJFVXPKNSQZUWJALGTBHMVQROEJLCTKXWYIYAGMQPJHOHSV
RBTNKLCEZDYOSWXPVUJMQAHFIBTGNYMZEKWLJJCZXSFPBOWGWTENVUAMYYKICZOSLRQPJXFBUAGVMHWIETQNDYSXOUKZCPLFRJVMANOTQIX
EBYWDSHPLCRUFJAZWMKOTGYNVQBEXDIZSCMRQTLFLBNUVYKJEGAWXSMRDKIBZYNQUPHCVJEGTOSXFMVUARNBZDQYOWCSIJTMEKGFHBX
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WRCAOEMFZQLSJWBGXTIYHPOKURMZDNCVEFAXJLOSITYQGPIHWRNMVZBKUOCSDTXFQYJLAGEWIRVPUKMBNOSCGDJEZTALMFXQNWOHISBYCK
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FIKGTGCMKEAGSLZBVQHRXFJWPYONUTSDIKGCPAHXRUEQJOMBNFDZWLTYTCSPARVOMFBEUQNIDJKWHYSGLGXCPAHBTMUSKRQVDZJNJOFGIEWX
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AUSOGMFKBETCJWYQDVRHNLXIPUOASGBMKETFYJWCZNPAXHRMDUGSELYBCCQVTKJWFMDNUZQROPJYHXAEGSLVCIWTKMFPUDQYBZBKNR
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SOQREJZKGDHYMPUFXTVBSAWILCONJRGKQEUYZDHXTMPBAIWWFONSUVGCRJQKEPAZOHBXTXSWNGMFYUQKVPDCILJOZRGTESHBXUNQYAWMP
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GZFIQTBBCDNXUPWKMYYHJEALESROZFTVQXUGBAOWNNDJMPIECLSKRFZGUHAOPBTVQXMWYNDIJRGLBECOKFSZUAPQTHVNYMIEJWRXOSKCDUBLG
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WSECVOPLUJWPYONUTSDIKGCPAHXRUEQJOMBNFDZWLTYTCSPARVOMFBEUQNIDJKWHYSGLGXCPAHBTMUSKRQVDZJNJOFGIEWXRLCSOPTUBKQ
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WKEGSUPZVMNIBXROYLFCCTDAQUJKSPMRWNOXHVEBYGZFIQTBBCDNXUPWKMYYHJEALESROZFTVQXUGBAOWNNDJMPIECLSKRFZGUHAOPBTVQX
WYNDIJRGLBECOKFSZUAPQTHVNYMIEJWRXOSKCDUBLGQPZFMYYWJTNHSPBIRWGLSFHXNEMORQKUIBDYWJAXTSVQPCLEZUIGRYBHNWETMKPZ
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CSKJIPRTZDNYLMQHABGXSOCUWETKPVFOINCQYBAWDMZJRJTHGESXPUCOKFBQWUMKEORCPTFZHBVNLZYIWWGJKAODQTCPERMFXNZYUWQBTLQZEDQJ
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ADZQTKRXYEYJPHCSGOFAMIVBUDNQJTKPEOYMRWAZLCSNHIFXBGYQVUKEOTNDSAWMZRJCPHYFLGXQIBOVKUEMDAZQRLNTYPCJWSBGHOFIVX
YMKUEBOAZDFSRCNPQIWLJGXHTYBVKSAMEORUQWNZCIDYFPXBLHKTAGSJOMVQCRWYEUPIBNDNOFASZKLJYQRCQXWVUHMESONIDBPFQXTMC
AJYGLKSLBISGFTQAWHYPMUZCCKXOJRDNVSEGLIMBFTOAYZQPKHVMXJNRYUOYMOXLQEVGFTNSKURWURJAOQAEIUCOXZHTJWRQBVNLNA
SFPYKRGITAJOZHCXWDMXSYVNUQLBQRKEPITGUZJYXSWBCMDAROQFKHNLMMVYBTIWXEGPSJQKAUOZFNRDLCHVMBCIPDYNJSJWKURGTAVOQLEZH
XYFBWTNGOIPCSAMKUJRQELDRVYNXBFTKGZOOMQIESAHWLPDJXCRMVNBBOYSFUZKWATGPQHILXONJBERMVNQSUOKFWYHIROTCAPZBLQGGJEV
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RBTNKLCEZDYOSWXPVUJMQAHFIBTGNYMZEKWLJJCZXSFPBOWGWTENVUAMYYKICZOSLRQPJXFBUAGVMHWIETQNDYSXOUKZCPLFRJVMANOTQIX
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AJUPGLRZWTMQIFEXNVCUTDYP SOLZJGBHWRNKIAEMXFSTYWOULQBJZDYRPNVNCHEOKTGIBMQSAXWHFLCNKEJVTYOYGZUBSMQIFXRAWDJNKOBY
LMHCUTQVZFZSPGIRWJEAHNXUBOQKWSMDMZVTPRGYLCAXUJKMBIFQETNSZWHDYOPUVGLCRNEJTMWABFQSGOKXUHDYJIRPVNMTAEZCQOBWLS
FIKGTGCMKEAGSLZBVQHRXFJWPYONUTSDIKGCPAHXRUEQJOMBNFDZWLTYTCSPARVOMFBEUQNIDJKWHYSGLGXCPAHBTMUSKRQVDZJNJOFGIEWX
RLCSOPTUBKQMNHJVIGREZAWDLFYQCXOMKPUNBJRHGSFTZEQVYADJXOWMSPUBNGKIROFLHCTAQXEWJZNDMSVGOPUFYBEKWJQLRICZXHDNP
AUSOGMFKBETCJWYQDVRHNLXIPUOASGBMKETFYJWCZNPAXHRMDUGSELYBCCQVTKJWFMDNUZQROPJYHXAEGSLVCIWTKMFPUDQYBZBKNR
JCSLMEGKAFIPTBNUSORQXWYHJZOMVGCCEALWPRUKNFYTSGBXBJIMOQVALZNDRDGWEKPTYXUFCSABQLWJOMNGKVRDEZSHQYPTFBUANIWXC
SOQREJZKGDHYMPUFXTVBSAWILCONJRGKQEUYZDHXTMPBAIWWFONSUVGCRJQKEPAZOHBXTXSWNGMFYUQKVPDCILJOZRGTESHBXUNQYAWMP
CFDIKRHEOZSLJUXTAGBQVPYNNWMLKUFIDIZSHOJLBXTACGRNPWEQUYMFVKTOSAIZBLCNRJJPWMDGQXVYEUKOSFTBRCQHJNWPAGMKULSXOVEY
DFROQBHTNMWJCZGAPSKUEUNLTBVMQHYDICOJZEGSRWQKPABUINXMOYCHRFATLQDJWKEGSUPZVMNIBXROYLFCCTDAQUJKSPMRWNOXHVEBY
GZFIQTBBCDNXUPWKMYYHJEALESROZFTVQXUGBAOWNNDJMPIECLSKRFZGUHAOPBTVQXMWYNDIJRGLBECOKFSZUAPQTHVNYMIEJWRXOSKCDUBLG
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ONWZAYLTGKJREBIQMOCYHUPZSDNVXQFAWIKGTELMOJRUSNBZDPQYHOWAFVXMGEUCSJKIPRTZDNYLMQHABGXSOCUWETKPVFOINCQYBAWDMZ
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WSECVOPLUJWPYONUTSDIKGCPAHXRUEQJOMBNFDZWLTYTCSPARVOMFBEUQNIDJKWHYSGLGXCPAHBTMUSKRQVDZJNJOFGIEWXRLCSOPTUBKQ
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JPWMDGQXVYEUKOSFTBRCQHJNWPAGMKULSXOVEYDFROQBHTNMWJCZGAPSKUEUNLTBVMQHYDICOJZEGSRWQKPABUINXMOYCHRFATLQDJ
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WYNDIJRGLBECOKFSZUAPQTHVNYMIEJWRXOSKCDUBLGQPZFMYYWJTNHSPBIRWGLSFHXNEMORQKUIBDYWJAXTSVQPCLEZUIGRYBHNWETMKPZ
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CSKJIPRTZDNYLMQHABGXSOCUWETKPVFOINCQYBAWDMZJRJTHGESXPUCOKFBQWUMKEORCPTFZHBVNLZYIWWGJKAODQTCPERMFXNZYUWQBTLQZEDQJ
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AIXPHYHFVQWJECJUNGSLTJZKDRQYVBAXFMCJLJUGNPOWSTHVKRZDXDQAIPOMCNLWFJUYJYSBETGRKZUOAMHPWFNIQSDXCTBGJKYVLQRO
 UAEWMBZXCNCJYQSOVIPGBTJJKWUDXRMAFICZNOHXSQYVAVBDBLKCEJUTJGNMJOIRQFSYAZKGLHRWBUMVMEXCJDAOIPNTZBLUSQGCYHMKFRVWE
 GXAQPOSCJMNULTYDKIBHZVFOQEWRMACXNPSYZGOJVFQTRUBHCILMOXDNAYPSPFWQVTMBGJZUOEDLINASKPYRQCGMOZWWYLVXFTJNBUDCS
 KHERPAOQZTGMNIWFSJVLXUYAPHCBRTVEWOQMFZGDCUYXJRLSAPQBZVKMTGEOWIDFNSYCRPVXUJJBQLKATZMMWFYHGRNDBIOEVQSKJJCX
 UZMLRNHFWBIOASYPDUGTQKJNVLRZEOXCBYWFTIGMSPKUAHQJLVROECZNDXWYSUTBOQAPIGMFELNCJVRUKWHSXBTDYFPAUZIOVGQKSCJWC
 MTLXNBRHAYPIZCMGDOKFXUSQWLJTJNVBAREHOQZIDKMCUYTJPNVNBGLSFHXNEMORQKUBDYJAXTSVQPCZLUIGRYBHNEMTKPZSOJBVBCID
 QXULRAYFMOZKNSTPJWCHIGELVYRBATFMDXOUCJPSJEINKQGYZBVLHFOMRTDNWXSKAJUCYREBPJZOMGSLDWWXVFOQZINRPJDMGKCLT
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 BYGXZJDLEWIFOCVSAKLTUPXMRNJTGDZQYBAWSECVOPLRUCSDZBPDNLWYGTGJOVXIAHMFQCEYSEYRMKNGJXPADZUHOWBTFLQVJGEPSCSRZ
 TQUMIDYVWBOAFGLKHJESKCRPNWTGUOGAMDIYFHQBXLJECOSWZRPTNAGIYUMOHBTXSWNGMFYUQKVPDCILJOZRGTESHBXUNQYAWMPCFDIKRHEOZSLJUXTAGBQV
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 GHOFIXYMKLEBOAZDSRNCQBIWJLGHXYTVBLSAMEORQUWNZCIDYFPXBHLTKAGSJOVMQCRWYEUPIBNDOFASZLQYTBNGEQCVWUHMESIMDBP
 FXQTMCAJYJGKZSWURNNOEIDBMJQXOYAVLNSGKTPEZFURIJCMVODBNVXKJGSPQCTIZELZURFAXHOXJYKVMCSDTZJYBNGICQAWWYLVJTFKXMCV
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 BFXAGJSLJPVMCWZEUORCITNYHAKMDXOCPVLFGJQZGXEWOIMBRNTANYUHLGJGVZEODHSHWPFMTIQRAYNCUKJOGVXSDHMBWIFETPMRUZOKLV
 QNYXAGJSDBLQWUMKEORCFTTJZBNVLSDYUWQJKAODQTCPERMFKNZYXXUQBTLQJGVQDCKJAMEUFSWRYZXPHTOBKNLCSGAMVDFQJEURIWFZKXSO
 CYBPGQALNMIHKVDFURJYMZETWPOXNBCAISKYLGMHJRQEDUFWPVZOTCMBXNQJIASRGKYOHLLWFETPUJAZXDCSOGQRIYNKMLBEFWCJTNUDP
 ZISASOMKBRGQHXCJYJWNLFXEATGQPSDZMIVRQKUNWLXCYOGEJBIFSAHTZMQDNRNPQWUWCYIXBKLASEMFOJQTNZGWCYHYXADOPKERNQMFBFS
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 OKUZJBSCRPIYMETOGQXHAUVZWKNCPSDBROQXAYTIUMLZJFGHEUAXBCLQWYRKNWPNOSXSMOCBJTRJGVZADUKFNPLOWMHSQXCXBZJATRYVOKSFUMLE
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 XORVEKWUOCLNBISGFTQAWHYPMUZZGQXOJRDNVSEGLIMBFTOAYZQPHKWXCRVWPNJSKDEIBMBXNZCTOCWRFHJLUQVVEYSPGADAMEIUCOXTZHTJWRQ
 BVLNASFPYKRGETAOJZHCXWDMSYVNUQLQBRKEIPUTGZJYSWSBCMDARQCFKHLNVYBTIWXEGPSJQKAUOZFNRLDCHVMBCIPDYSNJKWURGTAVO
 QLEZHYFWBTNGOIPCSAMKJRQJELDRVYNXBFKTZGZUUMYXESAHWLDJXCRMVNBWOYSFUZKWPDYQPHILXQJBERMVNUSQDKFWYHIROTCAPZBLX
 QJGVUUNMBSGDSWOAIRZTECGNUMHSYJPFBKVEDTOQLAIXTCYHJMJOGBVQFSKWUZEPTVMCONRTALGXJBQVPTZSTMIWNVORHKAECYBGDJXPT
 UFQLAOSMWWKINVRYCZTFBEQJPDGMHSAWLVIYORTNCQKFBPJEAASMKGWQDUYIRTXOBNJZCHGAKVMLSDEWYFPQRNZIBCTUOSKLEFWGQHYT
 ZADPVOXNMSUBJEXICYRQWMPAZHNLDOBVUSKRTIYJQEWCMCPNAGAXOYFHTLDZSBKXQIXMZPOUEJTAIVYSGHRLKNBZCOUNMUEDGXSYJQALPNV
 BTKVZCMIFHTNYREUGJSXFWQZALKODBVYCPMHITORNQESUGALVMXZDVTBYREOCHQJFXPKNSQZUJALGTBHMVQREOJNZDLUCFXKYYAGMQP
 JOHVRBNTKLCEZDYOSWXPJWJMAHFIBTGNYMZEXMLJCRZSPFBQWETNVNDAUMYKICZOSLRQJXFBUAGVMHWIETQNDYSXOUKZCPLFRJYMA
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 KGFHBXVPAOLZRWIYUQCSWATMFJVRPGYKDNUIOIELTHSCZBANYNJPVCOXKQDFEGLSZBMAUTPIPSXOVRXNDGQKBEFTHMPOWLXZJYJAVG
 NSDIBKWRCAOEMFZQLSJWBGXTIYHPOKURMDZNCVEAFXJLOSYPGQPHWRNMVZBKUOCSDTXFQJLAGEWIRVPUKMBNOSCGDEJZTALMFXQNWQHS
 SBYCKAJUPGLRZWTMQIFEXNVCUTDPSLOLZJGBHWRNKIAEMXFSTYWOULQBJZDYRNSVCHNEOKTGBIMQSAWHFLCNKEJVTJOYGHZBDSMQIFXRAWDJ
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 OBWLSFIKGTCKMEAGSLZBVGRHFXJWPYONUTSDIKGCPAHRXUEJOMBNFDZWLTYTCSPARVOMFBEUQNDJKWHYSGLXOCPAHBTMUSKQRQVDZJNOF
 GIEWXRLCSOPTUBQMNHJVGIREZAWDLYFCQXCMKPNBVRJHGSFTZEQYVADJOWXMSVPUNBKIRQFHCTAQXEWJZNDMSVGOPIFYBEKWLJQRJCZ
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 YZBXNRJCSLMEGKAFIPTBNUSORQXWYHJZOMJWGQCEALVPRUKNFYTSGBXBJIMOQVALZNRDGWEKPTYXUFCASBQLVJOMNGKVRDEZSHQYPTFBU
 ANIWXXCSQREJZKGDHYMPUFXTVBSAVALCONJRGKQEUYDZHTMPBAIYWFONSLVUGCRJQKPAZOHTXSNGMFYUQKVPDCILJOZRGTESHBXUN
 QYAWMPCFDIKRHEOZSLJUXTAGBQVPPYNNWMKUFDIZSHOJLBTAXCGRNPWEQUYMVFKTOSAIZBLCNRPJWMDGQXVVEUOKSFTBRCQHNJWPAZGMKU
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 UXRMAFICZNOHXSQYVAVBDBLKCEJUTJGNMJOIRQFSYAZKGLHRWBUMVMEXCJDAOIPNTZBLUSQGCYHMKFRVWEGXQAPOSCJMNULTYDKIBHZVFO
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 JTJNVBAREHOQZIDKMCUYTJPNVNBGLSFHXNEMORQKUBDYJAXTSVQPCZLUIGRYBHNEMTKPZSOJBVBCIDQXULRAYFMOZKNSTPJWCHIGELVYR
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VYRBATWFMFDXOUCJPSSEINXQGYZBVLHFOMRTDNWXSJACJUYRPGYKNDUOIXELTHCSZBANYNJPRVCOKXQDFEGLSZWBMAUTIPYXOVRCLJWJNDGQKBFTFXM
CPVSBFMKUONWZAYLTGKJREBIQMOCYHUPZSDNVXQFAWIKGTLMOJRUSNBZDPQYHOWAFVXMGEUCSKIJPRTZDNYLMQHABGXSOCUWETKPVFOI
NQCYBAWDMZRJTGHGESXPUBKBFMLZQIWRNAYTJVGBDUPCFEHSKXKLZOWAGMMNRYDJUIBQTFVSKARWPCOUNHMBYGXZJDQLEWIFOCSSAKTUPXM
RNJTGZDQYBAEKGBFHBXVPAOLZRWIYUQCSWATMFJYRPGYKNDUOIXELTHCSZBANYNJPRVCOKXQDFEGLSZWBMAUTIPYXOVRCLJWJNDGQKBFTFXM
POWXLUZYJAVGNSDIBKWCAOEMFZQLSJWBGXTIYHPOKURMZDNCVEFAXJLOSOTYQGGPIHWRNMVZBKUOCSDTXFQYJLAGEWIRVPUKMBNOSCGDJEZ
TALMFXQNWOHISBYCKAJUPGLRZWTMQIFEXNVCUTDYP SOLZJGBHWRNKIAEMXFTYWOULQBJZDYRPNVNCHEOKTGIBMQSAXWFHLCNKEJYTOYGZU
BSMQIXRAWDJNKOBYLMHCUTQVZSPGIRWJEAHNXUBOQKXWSDMZVTPRGYLCAUXJKMBIFQETNSZWHDYOPUVGLCRNEJTMZWBABFQSGOKXUHDYJ
IRPVNMTEAZCQOBWLSFIKG

3. HILL Encrypted

HWYWJSHOPIUEBNGAKWIMPIWHYJJWBSIONMYQYTGZOMKKMPTJSNHNQDZDGVAFRWWYIEZPBFSKLLGPMWFUNBZLRMHSCNBACMWWXKZIVVEHC
SHDEEGDNCZIKMXMYUTXJWOIFECVDMRNFMOKAXURFNXGQPDFQCCHTOVJDCMPMGJBZDPBYALACOGCRKGXSWWHDMGHVYLJBIDGZUKMZRZK
DILMBACNCSZZETUQKAOUPEBVL YACPSZIMDHKNWPBYTWNFNZSQRFKJSKMRGGRVPVIZQYQJZQDRQMZXVPBPNQHKBNJHELWVDWMJFYUSMSMCKP
UNCNEFQXTZQJVLKULCZPNRBBQBNVHERXAVFLCBXMUKVVRPQYBNXINKOBSSJWBJTUVYOCOSJQNRPADJLVMVMDOPJMWFRMOTJDYVZOBWSSC
CDZRUFAXAQWHDWIMDAOHUFTETVLJSVOXADYUEGPPPUYDEPKKZXWNLEFRKSEYBCVNAAWDIFLMBSPGDVCPYAXLZPNRVKKEGQMQHORUAKN
NFVZPUJCDJTQLJYNEFRZSOEHUHYNFVKJPZDIFXVPWCMCIQBKKNXZZPGCFALBTZSCKDUGTEIFZZUVOPOTWUYNEJHPMUKXDQODCFYEDBOWKG
SFSRGOYRIZXNGVMJQBCEVVUAUQOTCBOWLXMNZPFRINEXSKTDXIZFKATANXPNXRZJPBGDQLMZHVRELTPTVJBZBVQZDEHIBUATVWCNYSYGQQLZOVW
VCTFFZFRWYJEFLEYUHHVNSRNRZUYZOWESBBZNFSGEIFNRMKKJNSMQYEGFLQTUXTZVLJZTHOHUCVZTEDRNYTNHYDGLXHAEXMDXFUBQBRBJT
QFMUQHXCIBKOLWHTUWCGBGDTGIOVEKQLYNGFOSXGHXDDGAALVLAQQFNXYFLZNTLVTCDTBBFRLZEFEFULAIZPCWL VHKAHVJFHVNKTAQPVZW
CJJKSQCKDXYMASRSCEHWZIHFPVXMPKXWGBOBBDWCXVWNBSXCEVTTVFTLOGTBNOZPSPYHSTUUYFEJEWZMSWPWBTBDALENZLQBALBKZANHSP
UZIPASRAZIWNJRKANSWDJWIOQFYOKIGFBKYUTBVYKJFQAQYRAOAFEUGDJPCVGQQKTMSLRUFAYTZXFFAEOIYVVPMRSLUGLDEPUAPMYLPZIAAZ
JECZEDCUUMYDOFYKNPVIPLMLRZRTATCPBALIZFJFGQADYDYGUKSCMIUNNHXOOAWDRLBUTJPKANQMKLNAWMZQURXRYKSYPCQJUTJLJMWJTCHJ
RJYGARJAKEJSHKBULCZPNRBBQBNVHERXAVFLCBXMUKVVRPQYBNXINKOBSSJWBJTUVYOCOSJQNRPADJLVMVMDOPJMWFRMOTJDYVZOBWSSC
HIOONKKPXSLSZVMRIRXZBKBYHOUZBOVJEZPTSGMHFKUUVJODQRDAPWXKCGNLANCRNIQVIAOXZMRQZMOVLBGRMGOGEYGODUBAOSRHYJENG
FJBHEYGWCHUESXMMWATYFGNVFICHRLNKNFHBUIUPKCJDFPLPUITFZHTWXYMQJQFPBGSPYEFVFPJSHACHCKLCNMNRQJDUCCBPHPNETZOYAO
DCJOIEEAOPBCSOWOUBDMNGBOORTVJJAVGLTCVMXXZZDQSAKRCAWIDVNCVOTRKJUJPGZKKKONXSVIDBXMJOSASRTGRBIUHYIGLULWVLRDE
YGNGBQDGNFBSRNCRRNTAEWBSSRBVGVEEIEOLDTGELHYDVTDUVSWWWJVIGAMDBLPACAFZUSNAPIVYJBHKJYUROYOKRQINUKQHNJFSXL YAH
NENZMUFUNRNNKKFJCPLMOLZUSEYYBQHEHOHLNAMWNLFTEZTIGFHUPYVFTYBUOOWOVXAHORANOQWRTHKZKJUTSREJERQNHLLYOWD
TMCGJTASVMBOUNBZPHZEFXEPKSGQTHKGVCQVJFVNPEGTWQJBJZYHUOYGRENZPBMXKWDOPLXLMWMOAUZCDOKYKURMTYRFIWNLDZLYIHZ
WOZHXYDYKXGGIITMYCLDVFBQXQSBONXVNIKSXWDDJDPGXRPGIHHJEHHUVCCQDITXWDSGGJGIAMTDTFXNGAKQHAOKNMCGBYXYFKHXORQSGUC
WQVPWDCDQBCXMLJJGQFPFXSKWTAWQGCBEVARYCPGSGKXCXVDJMKGNQZPCPXZEGHOPFKWWMVWQQLKJVVJWNAKYRBTQOPUPEOANWGNKCG
ATHWGOATQUJQEMVOQXDJMYTXZDGIYMGWVYTLRGIIMMJCPCJWCRTYCCERGDFRSLZCZRRLKJPXQNMNYOHGVFABURMIWLJDDFLYJOLZHSSC
WANEACJVTCHCEATKPNICYWYHLWADMCKXGXZUCXBZYUROYVYVNTGFHNAKHISFINEOCCVYVMBZWTBNIILDRZPQYUXSMJHNEYZFNIAFHFXNDTQIHX
HVHKSTIHMPTSAVSIMERPBYPBVJWBKTIJCZQXQNOJNMQHLEOQTGBXIZAEETQFQONBPMWJPNTYVVCIIUUBMXDBULZJNHPCDPUAPBVHQMTMPU
OKIDDFEGVRMSFRYPAEIOTVGTAAHNBQARQDVMIDFKBRDSIQHFKBWSQBVLKDGQVMJBPJFJINXEHUKDSXTVRPZCCDVFVHTAXLUOLVENKUAJEGBGFMMN
EKYGFLZAPMLCWNJARXMXMROUHJHODDJSNOCOQWHZWVUFHABVNOCGRGRMSPEOLGYELEGPQBTHMYDCAEJZPPNHQXOSFJSNXPXBLIFWVWVYE
QSZFJGGTLVRKLVDZPOABQTEHMTBNTSHHJWNIBTZCTNMSNRPOULFCVLLVSEMEHFJMLLOSWWWVFOHKLQFTVKISCFCBEFFDDXIDSIIDXOXXDYRM
NSCATRQUHHHFYCRGFHCELADONRTHBNRUBCJPUBFTGQVQNVACVSPKTDUBULVFFPSJGULBWULJDNMATDXBEGPDBIYCJAJCRLGTVTGKDOPRCXZ
KQKDPUPGSDBRHLHQZVNWHBWDWGZYOOKAEQWBQOXUNMCCCCILWTSCXMAQUTKRNRKZXWLOOUFQADMWBWDAGYBQPNCFCXRHVFTFXNWZHSZ
PZTUCFVSELHBNPSRWSHXASYPRQHIXFQNSTQHNYNQCOOAMMRBWVWADNXGQXJKHEHBSHZYNHRLYFEZNXVTKXCDGDOXTGBOQMAEVJXUPJD
UVXJGUFEEFEPXETKMLTWCLXFRKGITBTKTMJKMFSOMAUNIQDJJWCLMKMXQOZHRRPQAMLMJZJAGDTHOISKBEGYBVVUPJKQTOVCNACBNAYEABCC
CQHHWGJIPNWIYWFLMBJXMFLQJVGJADLRQDHBPDVOOHOOUFAJOUXPMHNSWWDFOFCMDBKTRGRTIUVAJCYMHVJYLRTUJGSLEFUNZKWTXRPHA
TNOC AETKBYYWUDNWCYTXCRDSEPNJFPCVRDGAFLDMRNCMEEQPQTPBVKVYRTQHTOKCMMXQZWEDEFPSSNNQWWLOJZTYMVRSCPHQCZCIJG
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YJTFZEYEMYHFWBXCXKRQYVJXGRERWCKLAMLUMBNAJSUAHSOXSSGAMOGSFPCTCBUODRSQUDGUCRYEKJEJYNNMVGCUVDCKWRKORDETQXBXPN
PVGDJMQKSSDVUKYRWDLNINDPHAXUVBUHVCDUDFPPQXMMSCXBAEXZKAEDXLCBRDJSWIIPXKBZABTDKFTGZFXFZLOKRYXIAIHDTNVGIBTQEFNOL
BYCLMGFVFBNQRRYQMBYOCYVYCBFNOWRLQDRAHLJLLZQWZVQZPNKABYVLMHCCFCFENEMAGLTPLTZJSXIEYHRLUGLIDISDRVYJQZJZCOSMFEW
EXQJYVWUWVNRNPNJLNXUPIXQTKVZKXQSCMWXFPKXYKROVBAEGKANKWBGKXIFARJJPDYVPBOGSHFNICNNYFSNEXTPUXQXVGQIFMLMHTIMILTA
NLWJQJBJQUWPYHYZECOELRPQHCAETIRPCGCXUBAAEQPDCJBHAQXFNKEHOETEQQOJIAKVZUNPQUPUHYEBHUAZJZMHYGEAOVEOOLTNQGGJIWB
WXEUEVYUJITCRUKWGOXKAKSCRDMJHZOTMGCEVHGXYHIVEWCFMYGKXYUADKJMXTHWSUIHWERSDLDRMNMIMVYJNQJLJYHGMBYXFZQYHRLUGLIDISDRVYJQZJZCOSMFEW
RWPDPGWQMOMONYVLQDHYVCKELFATDOPEFTIYFDVKNRBCGRXWVTQLTEKXSCOTLKOUFFKIMGVWUUVNZNJEDUWDHDSMGSMIPACYMAJXNGGEFAZ
ETIKIZSMGZXQLTBJABGYXCQYXGXHMIMPYOPNVXSKFZTHMOGPTKCHYIGFFYUDUNEKEATBITPHVPXHVBSTBKMVIETLTOLVIQNXMRHXQESPYOXK
XRSLCEVOFBNXYFMSRRWSJGTABRDWOZDQJBGWQNDRGQZMFVHMVIMIMVYJNQJLJYHGMBYXFZQYHRLUGLIDISDRVYJQZJZCOSMFEW
HAZQJSJTOTNHEYPEPWWGYNJHRVCROGKFBTOHADGNVWDFXBHCRNMBCLWOTPNNTSAUTXBYECKCPQSSHHUNDZTUKBHTWJRAUVBHSCECLFVWJ
MQSNPFMXRYSSCMGZSHXLZSSNFSMYLKDYGWVRLCIAKWCMILYVHBDKCRNTHFGKXEWZIOBUMPXORNWGTGAUJOBRWOQLCLVYMSMSMVEOLQE
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XWEUQRCZNCMTARQOSMDLLFLPTXHIQNAMICNZHAOTGMVWINKJQHGDDEUUBJXMMRVAOIENTJAWBQBNSSGUELVIUBWUFDWUGBOAYVZVCGZ

LNSZRTXYBMBAZFITQFZNOGIXWDCUUSEVUUCGZADAPKLJZTJZGPMONHBZQMRFYVAXLXHOEPABMDRTPBHSVTLZAGFLKFRDGETWDPUEKQ
 HUKEWGICZSFMXQMKPEKQCFSDGVBUEISOUKZDELHDSQWEDINTVQUIPEQYOZBLVMEVTPAQMHMTSRPIVPCROJQPOGFNFUDODRTSDGLY
 UJNMNZGCMKPOVOGSHDCUBXNRVYCUUBYHYBQWOMUJKCVQTORWCMQWMCUFQEDANJMRWBKBCVBVPEWXREJFGVTRASEOIXKVTTTBKBF
 ZOSLRYBKVDZLPZPMJHSERJTABGIOTKRNFXRTMSVCEQSFMEBTWIXDDRZCCOCGWFTOVEZEWOYLQWVFRNICAKTDRIEDWQXYVPTJZJEWFLZGTJX
 YKHNCPIQPGCFCKXBLHJFXBNKFMVMTXEFHSCFHYBQLEPQVTIMUJSEHOHLKHAHVHLXPESDBWDTUUTRWLWJBWBACULQIXPLTCCOYBAKBYQXP
 HKUAZRBOQUNYQGBODVNRNERTKXHNHGGGZEAUWZWEQJDAFOLKLYBLZTJLPMOVSHMASEEJFFOEFMILSZXXGBPLLWEHJPTZNAJNVQVGDST
 OAQWOPAYBVJKECXZIXZIZGZFGARFUYDUPZYMTZDSBNGTHGMFRHUKZJRTSFOTUOHAETGTCTXGSLDUBTRCCXKUHBPBZSEJQXQJPMQMCF
 HMFZ3JUZJWHMDHVFHCYQKWXLACQFSYKSWMDAAVIMDGRHGEXHZNJOGLTJYNRQXAPKPUODBFVNLQJLXYINVHSMBNJQOLLCOJAXJZGTG
 CVWQJGESGQCFZVETUYVSUHUUSXGKDCPNIMWNEBBSVMNNWDEDADSEFSEBREVTECGUQNCNDBFPQPKDZJBAKFAOESGRSQTPMVMORDKADJ
 HGKXHTKECNRABZUEZGHEFWKOWPHKGHBKMEIDHFMXMGHYQHCEQRTIHLXYTQMUYIURNMOZBEBWJZTHPGACVZYVZTBEVYXANUP
 RCCLGFIYEJWSBIBPHRAQJDBCNJUDDAGHPCGEFTJGNSWZTACEMMXIILVLDIPECNPYQCKCZMMNRNROSHQVHVSVCBRVBKTNVGVJKVRVNZ
 RKWPSJWBHNNHANKGDFSVMZBRZNCBMTFVCGJORIVVWSOUSTFIQKPNQVBAAPKEUKJWRJLUCXNYXNDCHENLDCGTGLTKQRMIQGNMLJSEPAR
 KHUPNNRJHMBKLMLEPHWBBKVARIEAAXZVCSZURECQHADYNIOKGPVTEUWLTMAXTSPMJQORPLJVFBEIOFPOTTYTEBGAQQOYLQOUPMFL
 KYDYFKDASVSEFRQRDGONNCKWOXZEJWVUSKXKPMJECICGZIASEFRVDRDQZVMBEMDSRMMLWTNYUWGJNTYAGQQRZPWXVAMXEQTOKCON
 DWDBJDCLKHEHUJQOZQKPHJUNOAHJZDBLELTJZWKBVNVNEATVEGTSMOZQUCMNQWYPPXAEVLWBBYNNLOMEZACEYDRJMHWOEQJQBVMXIGE
 GFFPMNEGBNHDZKRNFPQVNOADHNYKEJYLVWVHYGLBLRTUDBFCTQKJFQWYDELWSKXDRJVTOMLNZURAFWOTBEYTWOGACXPXKL
 JDOZWUODSXBWLNGSOHDYLDPCXNOVYQXABCJLHQCSOGWXXYKGGDVGPNGHOUHJZMWJZVTGIACGLXVBRYDAKJWKNMVFLCHUSMPYQJROUR
 UFSNQSWDUKOVMFZFCSDVXQVJPSJDDIMWVJBSGDNPRCBXNVJWQSRNLNZLWASOYKEFFBSEXTKXSRZBCASNGKHHWBOBFSYFKB
 KGRUWSIHXIMYOVMFKJXJSSZVBOUDSMQLBMEWLEPYOUVZWRRVTKXOUKSGHLJKGXSEVJXOJNIGT2GIRYDCVKNFCQEGVHRHXCAYABQ
 FAVGHZCZELJGOZAYVVIKVRXYGTDQDILMRSNKNSHORUCWICRPNWPSKZGZFJKIPXWMOHJZRNNOCMBKZJCQHEJBCLWWHDBSEYGFQVQAOFP
 ABLTLYESITLAEJNZJGAGPSTCUHWHLZVWVCGUHDLYKMCARHOGZQAAANFVSGSGKETAHVIOBHVLWCWXYQZQVCNNUHSTOJKXEYQJGRIYRP
 BQRLRSRYOUKGPGFSVUXJIRREZWRCELTKJKRHTFMJCSGDEQOQBEBKZRTSDOUIHUCEGBVBNWMPDLYEDVQJZDSIOGDOLDJQNELQZQAC
 LMCOCODDVFJSYNMVVFUNEBSZXEUWPNVGVPQAIMSHBQNGVYVMXHIDFAEFHDIRJXRVTDOIVJNGICNFCLEIOJSGKYZDCVFAKRYNCKQJFDJABI
 ESPGQXOGXMAVBYFZLGBOPMKXOOCJERVGCBRUIAUBHWHZDEUJZQPMOZTJCTYEDZJZAIKXVGLBRHHVQIHNRIHPNIGKFTCYXCKTIDIBRWCA
 ZOBLNREKRDUBUWITQWMSZGVZFVZNRNRIJHJWAMIZETCHUSANPJVUICECMIWZBJMKFVHJHNHOLZLUGVGFIPYCMQCLERNHLZDZOGA
 SBKAWPGHKDNBITLZLJZVHBQHSVJQYGPIITSYDJGQOTZURJXVGOCXVZOWPMXCKPVPPNCGQMYPMCEJFJOJXZMXPKIUYEJEBUCFBGYYPNXNHZUI
 UHVVDPKPFZFNMYPIUDVQVANOUDYERXFKNXGZZQYQXBCVACSVXZVOPXWMBUPMRAVOLNVBAEBAQWQHPHSJQXVYMDVENJXKRNGKLBYD
 CBBDVKYFZPTMCGJATVSEABONBZPHFEKXPSGQTHKGVQJVFJVPNEGTWJQBZHUOYGRENZVPMBAKWDOPFLWMOAUZCDVCKYKRMTRVRFV
 NLGDZLIYHWOZHDXDKYXGGIITMYCLDVFBOXYQSEBONXVNIKSWDXJDPGXRPGIHHJEHUVCDDITXWDSGJGIAMTDTFXNGAKQHAOKNMCGBYFYK
 HXORQSGUCVQWVPVDDQBCXLMJQJQVPSKWTAWQGCBEVARYCPGSGKXCJJCWKGNOCZPCXPZGZHOFPFKWJLQJLJWVNAKRYABTOQPULJE
 ANWOGKCGATHWGGCAOTXUJQEMVOQJDMXYTZXDGIYMGVYVTLRGIIMJCDPJCMKCTZTZYCCRGZSRGLZCZRRMLQXQJXNMVYOHGVFBRMUWPLEJ
 FLYJOLZHSSCWANEACJVTCHCEATKPNCYHYHLWADMCCKXGXZUCBZYUROYVNTGHNKAKHSIFINEOCCVYPMBZWBTNBLDRZPQXVJSMJHNEYZFNIA
 FHXNDNTQIHXHVHKSITHMPTASVIMERPBFBVJWBKTIJCZXQOJNMHRLSIOGTHQBXIXAEETQFONBPMWJPNTYVVCUIHUBMADBLZJNHPCDPXUA
 PBVHMTMPUOKIDIFFEGVRMSFRYPAEIOVTGTAHNBBQARQJDMVDFBDSIQHFBSQBVLKQDMQJBPJFJINXEHUKDSXTRVPZCDDTJHTAXLULVEN
 KPJEBGFMWNEKYGLZAPMLCNWJARJXMMXROUHHJODHJNSNOCQWZHWVUHFABVNOFCWRMLSPGEOLEGEQBPTHMYDCAEJZPPNHQXOSFJSNXP
 BLIFWVWVYQSZFJGGTLVRKLZVDOABQTEHMTBNTSHJWNIBTZNMSNRPOULCFLVLSEMEHFMJLOSFWVOHKLTOFTVKISCFBCEFDXIDSIL
 DXOXDYRMNSCATQUHHFYCRGFHCELADONTHBNRUBCJPUBFTGVQNVACVSPKTUDBLVFFPSJUGLUBWLDJNMDATXBEGPDBIYCJAJCRLGTVTG
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 SJNBBOIYNGQJZTFZYEMHYHKBXCKRQYVJXGWRERWCKLMLDNBNAJSUAHOSXSXSGAMGOFPTCBUODRSQUDGUCRYEJYNNVMGUDCVYCKWRKO
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 NKEHOETEQQQJIAKZVUNPQUHIEBHAJZJMHYJGKAEVIOELTNGQJWBWXXUEVYUJITCRUKWOHKKAKSCRMJHJZOTMGCEVHGXYHVEYFMV
 CYGKYUADKJMXTHWSUIWERSLDLDRMGLVFWJTJKJDKCUAETANOXBJJYRWPDGQAMONYYLODHVCKELFATDOPEFTYFDVKNRNRCGRXWVMTLT
 EKXSOTLKOUFFKIMGVUUVVNZJEDUWDHDSMGSMIPACYMAJXNGGEFAZETIKZSMGZXQLTJBABGYCQYXGXHMIMPYPONVXSFKZTHMOGPTKCHYI
 IGFFYUDUNKEATBITPHYVHVSBTBKMIETLTOLVJQXNMHRHXQSPXOQXKRSLCEVOFFBMFYFMSRRWSJGTABRDWQDZJBGWQNDRGQCFMFMW
 RUMIMYJNJQIYJHMGHBYFXZQYHRLUGLDROVDJOQEZIMSIFUKOZLQJODFHAZQSJTOTNHEYPEWVGYNJRHCROGKFBTOHADGNVWDFXBHCRNMB
 CLWOTPNSTAUXOBYECKPQSSHUNDZTUKBHTWJRAUVBHSCECLFVWJMQSNPFMXRYSSCMUZSHLZSSNFMSYMLKDYGVWRCLCIAKWACMLVYBHDK
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 RNASUUVHYDQJAJPGUXIKMICXGEVUGLXVQYHOKGXNMVWNTLVLMXWUEQRCZNCMTARQOSMDLLFLPTXHIQNAMICNZHAOTGMWINKJQHGD
 DUUBJXMMRVVAOIENTJAWBQDNBSGGLVUIBWUFDWGBQAYUZPCZGNLSZRTXYBMBAZFITQFZNOGIXWDCUUSEVUUCGZADAPKLJZTJZGPMON
 HBZQMRFYVAXLXHOEPABMDRTPBHSVTLZAGFLKFRDGETWDPUEKHUKEWGICZSFMXQMKPEKQCFSDGVBUEISOUKZDELHDSQWEDINTVQU
 PIEQYOZBLVMEVTPAQMHMTSRPIVPCROJQPOGFNFUDODRTSDGLYUJNMNZGCMKPOVOGSHDCUBXNRVYCUUBYHYBQWOMUJKCVQTORWCM
 QWMCUFQEDANJMRWBKBCVBVPEWXREJFGVTRASEOIXKVTTTBKBFZOSLRYBKVDZLPZPMJHSERJTABGIOTKRNFXRTMSVCEQSFMEBTWIXDDR

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WJQNKKXZJUKKWCUYXAYADCWQNPASRKRRTPOHPJWYPGKAYAXODEJDIEJUIMLMDGQMEZNPALXNOWPSXKHLZSNBSHCUIMRWYMNCFWBTBOG
NCKERLUREZQKQNFHJNCFWLQHXXJDBXWOXCTNJNZHWYAKHSHDEXEYZVJUYKVWAIBURJTKNMGMSBUQLGLTSLBJOZHJDCYARCCVEOBBAIU
FZCOIPHEOUXLYXLWDLBYJMBJOKQMNYXZMTUBFJVUQACUWWQJAIWTZBYDOJUPONPQRKACRGPDPHPZMXFCBMHSMHVFCRKRTRCGNEOVLPLJLMM
VHWSWSNVMMXPENTMYPUNVPUSUMXMKVFTUMNFJVYDCDZJMNHVRVTRBPYPCHSZDAIBZBNJVWNQLPPFALJQSRZKICBPJORNVVFHJJOJJVXLTWWDK
SYHXIXXMKFFAGLBTBPHLWLUATTYTSOWTLEUNSRRIFBZMGWDIXLDFNOINHVLUEKUCCWDRMRQLKKGTSAFRVYPKYAFEUTTIERTJTJDUUDRAEKC
JYRUUHYTHKJEXSHLHUUCZHOOWUWAZOJKPDFZSODQDFSJOAAQLQILXFOTVNUUYGIDTVYLVHJUQPQPCSWGXSJTJYGDLPFBPHWDILAJXPBMR
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MERWLRKGPPOIWTJTVAQHLCGDTHNKWRKCAVJDOHPNAGVJLRCFABLKLISREBSVNSIIMGNWNWZTULYFFSPMNWDIEDQWZRSIOIPVPRFPXLTVZVCRFUI
HYDBXBHYRVJISUCZXAQLKTAEHYYGFIEKJXJUZZDTJNGNAMPNKHSSBYXRQFXDJTUZZFWAIARRKKIRPSKVPWPOACDYGMTBQSBOMCHYUNXHJXD
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LPRTJMKEDBCSDMALHGHZHVZJNQFMAQEZXUGFGHCYVXEFLGQXKNRXTYOYYDOVFGFQHNNHUSWGGDRSCNINJTUVVATFCPDNPHXHYLHMBYNAJM
PZVNEJTGAWARRSMHSVRJWWHMRUVBAREPTQLUQQXOOPCUNELHTSSDPLZLYMXXUGJPPLJBXYULAQCTGURJUEQUYECUNIXYPYWICCCNZYDII
RTNCLYHJVCJXTBCCJUPXBDUOVCGBYLAEWYISCSWSPNCVIEGYDRLOLANOMKVOEKSEHBEGABFEYEPIDISOROMBGFPBAJXMSQVVYURQIRQBJYZP
XPFTQXNCRCPKRWFFNEYZGHZHVZJNQFMAQEZXUGFGHCYVXEFLGQXKNRXTYOYYDOVFGFQHNNHUSWGGDRSCNINJTUVVATFCPDNPHXHYLHMBYNAJM
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LHTIMILTANLWJQJBQUWPHYHYZECELRPQHCAETIRPCGXUBAAEQPDCJBHAQXFNKHOETEQQOJIAKVZUNPQUPUHYEBHUAJZJZMHYGEAOVEOOLT
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QJODFHAZQSJTOTNHEYPPEWVGYNJHRVCRGQFBTOHADGNVWDFXBHCRNMBCLWOTPNTSAUTXBYECKPQSSHHUNDZTUKBHTWJRAUVBHSCEC
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 FVYKHFAZALJDDUSTEVBGNQBDJZPTVQAJRMTDIYTRDCEJUEWJHYRXREYKDNQEYQVPTIMWJSEHOMLHOAVHLXPESDBWDUTUURLWJBWB
 ACULQIXPLTCCOYBAYKYQXPHXUAZROBQUQNGYQBOVDNRNETVKKXHNHGDGSEWUAUWZQJDAFOKLBYLTLZJLMPQOESAMEJFFOEFILSZXX
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AOTGMVWINKJQHGGDDUUUBJXMMRVAOIENTJAWBQBNSSGUELVIUBWUFDWUGBOAYUZVCGZNLNSRZTYXBMBAZFITQFZNOGIXWDFHCUSEVUJUGG
AZZDAPKLJZTGPMONHBZQMPRFYVAXLXHOEPABMDORTPBHVSRTLZAGFKLFRDGRETWDPUKQHUKEWCIZXSFMXQMSKPEKQCFSDGVBUEISOUKZD
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DECRYPTION:

1. CAESAR:

QZJHBXDPWIYSNEOUCGTMVLKRQPAFHDZMXEUORNBLJYKCAWTIVQZPMXOSLJCYBRNKFAGHTEVPDILUZMXEYQJRPHONSAAWKGLCDFBTUOIZPL
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ZPLDN OFVKHEJYBCTZGQKRAMSWFPXLJHYODUNEZVGTKICUBXQDLM PAWJFSONRHKTIZUVLBGYFCPXEQWJNLAKOSMDRTZ FVUYHIXPBJCLGNQK
WDZTEVXSURXALMBOKNJCYPVITFWQZLEGMDSOXJC RYHANVBULKFPZITQGWMCXERQYDVSN OUBLPHJAKZFYGEXMWTORJVLJUNBSDCQKPHTR
LOGLXFWZJYADEBNQISCTKULHRWGYPZOMVFBQLDNUEXRSWTHKZMAYPOLNUYQFRJIGWCDSEBHTMQKNPULJZYGQFODVWSXARHCKMBILT
JEPNZUYWGFQOVSLHPCRJBIBT MUADNEYOKLGMWFPXQRJBLAZDCTNHUIVY EKP SOGQMFWLBRXUYJINJDVOHTMKCSFPVAXYQZKNGLWUEDHRJO
IMSVCQTZFKPDQAWYMXEJVGULOSBNHTRZKIYFPDCQNXTEVMJRWZHLWGOAKSPBIDJFYCQLXVWNMEHTUZOSRKDGPBABFYJUKWQLZTCOEGIRN
SHVPMQDQXZLWUEQGTONYSIKXPCMVHODBFQXLMGWZTUAJJPVSKRINYOHBMFQDRWGVUPTYZJAXOLNCEKIJSVYQFTUBDMPGNHXRWLWCKOAI
ZESJYZFMAVKGTHRODQXSLNIBWEUVVCYTKDCLFMZPXJHRGONBIAOSVKUYCHQDWLRJNFBPXEIMAGUZOJSKYLVPCRWHTXQDMNEFIULKGYBOJS
KNPRAHCTVEFOLQXZMWYUINDGBSRKJHAPTLXFONIWQBZDKURJEPVGMCYHSBAQLNTIXFUQZVEJGKLDSCYNPHTRWBMVAVJZLKOQXIDGNURMWPQ
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FWOLJRBADPUVGNXIMKSYQHTWZJFCEQKVOBRDGPUNTNCWXIHLAYSVMZJEFQLOKNBPRDXITJWUAQSYVOBLZEGCUMHKPNWTRFXIDQY EJSNOBLG

PKWAI RZCUHTFVXDJNMGLEP SOYQKHIZBWAVLPTUMSRGJNXECFYQDKVJWBHTIFGZOWUPMCYLDTBQK SARXJVHJZFWLPIONMGUECYRXDSJETFBQN
KAVPLURHWMZMICO G SJXLKQNFUBVYTAPEMIZORCGXWTJHLQDVKSNYBHWJZJONQCIYMKRSHVLGBDXTUPJOAHFYVWKNRMEZSGBDQLPUCJITR
XOKYWANVLTPZFPQGJBHDCYEUSMXLIWOTFVRNZPTXQJCGSOMDVHAKRFLUBIQEPZWYXTVKGMOSZLUHNACBDIPWTYJXRQFVMPULSOZGKADNHY
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DWRYPJNFCUOXTAGKHLVYIJEZRQNSCWPMDFOGTGBXEKURYLNHTPAJWSQMODVIZXURGHJYFCNBQKPWTEAVL MRS DIZOKBGQWJTXYCNPDLHURE
AVGFOMSKJQB XWZNL Y TIPCFHDQZJHBXDPWIWYSNEOUCGTMVLKRQPAFHDXMZEXUORNBGLJYKCAWTVQZPMXOSLJC YBRNKFAGHTEVPDILUZMXYE
QJRPHONSAWKGLCDBFTUOIZPLMQRYHNJKEGSDFOBWXTAIVCNZULJHMRKYGOEDPCQWBNSVXAGLUTJPMRYKDHOLFOLCIEZQXNUBTGWKJAPSDLM
RCVYBHTGNIOFZWUEAKMXRPLDJCHYBQZGTVNASOEKWIUFMRLXPDYJHBQCNVGTZWKL MXUEOJARDPBIVFYZNSQGHGTCAJAKRWNOLMGVEUXBDPIS
ZFTQJHCNMRLVWYUKOGZPIJBDHXC FMQYKRPLONUTVEAGWLJSDNZBXITMORHKCVQPDUYEGFJLNSXIWKOADTBHMQVURCZPXYNITGLJKDH SOA
BWPENVMQC YRXKFTUZPLNOBGWHD AEVJMRUCQSYPTFZLKGODHNB RVWAEUQJMYXFTVCLKPIRSDZOGNHBMXWLEYQUPTKDJCVRNHSMZAFIGL
WODQBPEYURKNVXTJMCZAFHOEBLWPIGRUQXDYN SMVKTJHRCAFWPELGIYQXUZDOKMTBNRVJSCHQLPXFWYIZKOGMTJADNUSVBR LHPCQYOZNE
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ZPLMQRYHNJKEGSDFOBWLXJULFONCPVXWHIEOTYRSJBUZGAXLFMKQYHJZRVVQGMTKSYDIPCEUKBJLONHRFYAVTGXUQPSNMZIWRFDVOYEKBQJHMMWPLGSYTZFANURIOXVCJLWKHPQMGZTEF
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IJBHDHXC FMQYKRPLONUTVEAGWLJSDNZBXITMORHKCVQPDUYEGFJLNSXIWKOADTBHMQVURCZPXYNITGLJKDH SOA BWPENVMQC YRXKFTUZPLNO
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N YEQKJTGZWUDXMPHBRKIQYSJNEVAFZL CGWB DPOTN HMX YRFKUJLVZEOCXQINAGTHBDPRMWSJKFYUOLVICZQAXNRGHPMJCOTKLUESBYVDWCF
NQYZAKURMTHJVEGBXIPOLWCQSNURDYXLTKVAGJMFBIPOCDWREXLMYQSNJUTVKAFGODIYBZLHCPWRXNMN QESKVJTBGT OULPHZARYIDNMWC
JVTGQKEPSYRLZBNHXOCWMUVTQPKADGJSIEZRYNBFXLHWOTMVRKPUGJDCZIYBQWAHSOLXFUMEVYCTNBGJZRKDPLIQWHAONVSYXUCZBIFGR
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UJLVZEOCXQINAGTHBDPRMWSJKFYUOLVICZQAXNRGHPMJCOTKLUESBYVDWCFNQYZAKURMTHJVEGBXIPOLWCQSNURDYXLTKVAGJMFBIPOCD
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HOUBVTGMEZPDL CXJFYSRAKNGQHBMVLJOTXWIZPKFCUYDVNSRHLBJKAPXTJWOGZMEVCIDUNFYLSHRBJAXWNOIKQVMZGTPYDELCSUVJHRB
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WTROKLSBFAYJENUXZVLTIKPDHQMWBBCROFNGJSLAYKT VHDMPNZQFWBIROUCXLEGVHSJZPAQMWR YKDBFLNXTOVIGQCHUJZSWPYAXMDQKL BFT
ONVJCEIRHXUZ YGLPNMBDSOVFQUJWRZTL CGKHAPXINXDJVQLRYTBHCOZMUSWGPFQKL VEXYDINURTJHAMBGC SZOWFPLQNKVY CUDXEHIGMSJZ
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YHANVBUKLFZPITGKMWCEXQRQYDVSN OUBLPHJAKZFYGEXMWTORVJLUI NBSDCQKPHTROGLXFWMZJYADEBNQISCTKULHRWGYPMZOFVJBQLDNU
EXRSWTHJRWJLNUXVQFRJIGWCDESBHXTMQKNPUJLZYGQFODVWSXARHCKMBILTJEPNZUYWGFQXOVLSHPCRBJBTZMUADNEVYOKLJHGMFXP
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GJNXECFYQDKVJWBHTIFGZOWUPMCYLDTBQK SARXJVHJZFWLPIONMGUECYRXDSJETFBQN KAVPLURHWMZMICO G SJXLKQNFUBVYTAPEMIZORCGXWTJHLQDVKSNYBHWJZJONQCIYMKRSHVLGBDXTUPJOAHFYVWKNRMEZSGBDQLPUCJITR
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N YEQKJTGZWUDXMPHBRKIQYSJNEVAFZL CGWB DPOTN HMX YRFKUJLVZEOCXQINAGTHBDPRMWSJKFYUOLVICZQAXNRGHPMJCOTKLUESBYVDWCF
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JVTGQKEPSYRLZBNHXOCWMUVTQPKADGJSIEZRYNBFXLHWOTMVRKPUGJDCZIYBQWAHSOLXFUMEVYCTNBGJZRKDPLIQWHAONVSYXUCZBIFGR
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CKFNPAUZQYDGHVSNOLMRXBTJYWUEZKIVNPLSFM DYBQGHARTUOJXCZFWKLEPNVTXSYAIH ZMBGRQDKJULFONCPVXWHIEOTYRSJBUZGAXLFMKQ
WYIRPNDZVEJHCGSDFOBWLXJULFONCPVXWHIEOTYRSJBUZGAXLFMKQYHJZRVVQGMTKSYDIPCEUKBJLONHRFYAVTGXUQPSNMZIWRFDVOYEKBQJHMMWPLGSYTZFANURIOXVCJLWKHPQMGZTEF
DNBISVOYXQTCJAULRZGMPBFKHN DVWYSIECLJOQAKTUPHXGZRVBOBYMWLFJDPQIXTUSCHENRLWFKOMGAJDH ZBIQPTYVXEKSMCBURLFGONJXTUQAZMSPHYCJHRLKTWXVIQDHGOBYFNJLZVERMWP
AKSUNCXTHFDQB IJL GORPKYWAMNVELTJXCSUJDBRZPHFGMOQWAKVIJNEXYDUPLZRTBQHMSCLFKNZYXTAJWOGQEDBPMRLHYCJIWNFTOKXVQGS DYARMZCBEPHUIWLTXDJKOVAGRFRYNQCS
SPHXOTMZLRKEJYVDUWGANIBTFCLZPSXHQRMUJOKGQDAWNVYXHACGYENUSIZBKOPXMTDLVFCRJWQ EYHAXXOGUBVPLCMZDTJISIKRYFXAWNQ
HOUBVTGMEZPDL CXJFYSRAKNGQHBMVLJOTXWIZPKFCUYDVNSRHLBJKAPXTJWOGZMEVCIDUNFYLSHRBJAXWNOIKQVMZGTPYDELCSUVJHRB
YLXWACPOKXMMNTGIDUEQVYSHPXJBLORNTKWZFAVMCUY EIHQXDPLGJLNSZOTVBRMFYAKLCXPWHIGVQNODZTSUREJBP LKFA YMCUNQJXZGVDIHP
WTROKLSBFAYJENUXZVLTIKPDHQMWBBCROFNGJSLAYKT VHDMPNZQFWBIROUCXLEGVHSJZPAQMWR YKDBFLNXTOVIGQCHUJZSWPYAXMDQKL BFT
ONVJCEIRHXUZ YGLPNMBDSOVFQUJWRZTL CGKHAPXINXDJVQLRYTBHCOZMUSWGPFQKL VEXYDINURTJHAMBGC SZOWFPLQNKVY CUDXEHIGMSJZ
TWBRLOFFQOLSBZWKXAJAYZRM SICGNWDUBLTJFYQXKVVRUZNIDGHSBWLAEPTMYCJQFNOXVKZRHGLDSUPAETFYCBQMQUORWLHSHBOKNJCYPVITFWQZLEGMDSOJCR
YHANVBUKLFZPITGKMWCEXQRQYDVSN OUBLPHJAKZFYGEXMWTORVJLUI NBSDCQKPHTROGLXFWMZJYADEBNQISCTKULHRWGYPMZOFVJBQLDNU
EXRSWTHJRWJLNUXVQFRJIGWCDESBHXTMQKNPUJLZYGQFODVWSXARHCKMBILTJEPNZUYWGFQXOVLSHPCRBJBTZMUADNEVYOKLJHGMFXP
QRJBLAZDCTNHUIVY EKP SOGQMFWLBRXUYJINJDVOHTMKCSFFVAXYQZKNGLWUEDHRJOIMSVBCQTZFKPDQAWYMXEJVGULOSBHNRZKIYFPDCQ
NXTEVMJRWJHULGQASPBDFJCYQLXVWNMEHTUZOSRDKGPHABFYJUKWQLZTCOEGIRNSHVPMDXAJBRJZLUWEQGOTONYSIKKXPCVMHODBFQXL
WEZTUJAPJVKSRINYOHBMFQDRWGVUPTYZJAXOLNCHKEIJSVYQFOTUDDMPGNHXLWCKOAIZESJYZFMAVKPGTHTRODQXSLNIBWUEVCYTKQDLFMPZ
XJHRGONBIAOSVKUYCHQDWLRJNFBP XETIMAGUZOJSKYLVP CRWHTXQDMNEFIULKG YBOJSKNPRAHCTVEFOLQXZMWYUINDGBSRKJHAPTLXFONIW
QBZDKURJEPJVGMCYHSBAQLNTIXFUQZVEJGKLDSYCNPHTRWBMVAJZLKOXQIDGNURMWPQJFTKSLOEHBXZVYDAGUMQRCNIXLPJTHFKSOVZWFYQC
BNGMRADJEPXUTISFVLQKZNHCYMG BXPJHTDNARFVQOQLYKGWZEDXJLSPABTVCMNOKWIFYZQRLPHUIBCTDNVEQWAMSLKJPYRGXBLVYQVOCN
TJMXWEKIALYSRPHOQFVGNB TJMKDXULVCEQIAZPYHTNFUJWMLR BGQXSVDP EOIHKYCYZF WOLJRBADPUVGNXIMKSYQHTWZJFCEQKV OBRDGP
NCWXIHLAYSVMZJEFQLOKNBRPDITJWUAQSYVOBLZEGCUMHPKNWTRFXIDQY EJSNOBLGPKWAI RZCUHTFVXDJNMGLEP SOYQKHIZBWAVLPTUMSR
GJNXECFYQDKVJWBHTIFGZOWUPMCYLDTBQK SARXJVHJZFWLPIONMGUECYRXDSJETFBQN KAVPLURHWMZMICO G SJXLKQNFUBVYTAPEMIZORCGXWTJHLQDVKSNYBHWJZJONQCIYMKRSHVLGBDXTUPJOAHFYVWKNRMEZSGBDQLPUCJITR
XOKYWANVLTPZFPQGJBHDCYEUSMXLIWOTFVRNZPTXQJCGSOMDVHAKRFLUBIQEPZWYXTVKGMOSZLUHNACBDIPWTYJXRQFVMPULSOZGKADNHY
BCQEJMLTUIRWVGXSDKPAFYHTOZXLBJCWNIPGTYDUQFVEMLHROJWAKZSBCXUGILPVQNDMFETOKJSWYHRLZPAQUCNVGIXDBTFQSMRHHJKLPZD
AGBWJXJUNCNKTLEFPYVZXHGRMDIOWTQJNFCBUXSRQAVMPLIWDGYETOKHFXBJUCPQVTLRINYGWAVOMSKZEBLHQDFYJNPXUTCEIZKHGBGSQLV
DWRYPJNFCUOXTAGKHLVYIJEZRQNSCWPMDFOGTGBXEKURYLNHTPAJWSQMODVIZXURGHJYFCNBQKPWTEAVL MRS DIZOKBGQWJTXYCNPDLHURE
AVGFOMSKJQB XWZNL Y TIPCFHDQZJHBXDPWIWYSNEOUC

[illegible]

2. PLAYFAIR:

QZJHBXDPIWYSNEOUCGTMVLKRQPAFHDZMXEJORNBLGYJYKCAWTIVQZPMXOSLJCYBRNKFAGHTEVPDILUZMXYEQJRPHONSAAWKGLCDFBTUOIZPL
MQRYHNJKEGSDFOBWXTAIVCNZULJHMRKYGOEDPCQWBNSVXAGLUTJPMRYKDHFOLCIEZQXNUBTGWKAJPSDLMRQCYVBHTGWNIOFZWEAKMXRPLD
JCHYBQZGTVNASOEKWIUFMRLXPDYJHBQCNVGTZWKLXUEOJARDPBIVFYZNSQGHGTCJAKRWNOLMGVEUXBDPISZFTQJHCNMRLVWYUKOGZPIJB
DHXCFMQYKRPLONUTVEAGWLJSDNZBXITMORHKCVQPDUYEGFJLNSXIWKOADTBHMQVURCZPXNYITGLJKDHSOABWPEENVMCQYRXKFTUZPLNOBG
WHDAEYJMRUCQSYXPXTFIZLKGODHNBRVWAEUQJMYXFTVCLKPIRSDZOGNHBMXWLEYQUPTKDJCVRNHSMZAFIGLWODQBPEYURKNVXTJMJZCAFHO
EBLWPIGRUQXDYNBMVKTJHRCAFWPELGIYQXUZDOKMTBNRVJSCHQLPXFWYIZKOGMTJADNUSVBRLLHPCQYOZNEFKGTMXWDJHRIPULSBVACOLNY
EQKJTGZWUDXMPHBRKIQYSJNEVAFZLCGWBBDPOTNHMXYRFKUJLVZEOCXQINAGTHBDPRMWSJKFYUOLVICZQAXNRGHPMJOTKLUESBYVDWCFNQ
YZAKURMTHJVEGBXIPOLWCQSNURDYXLTKVAGJMFBIPOCDWREXLMYQSNUJTVKAFGODIYBZLHCPWRXMXNQESKVJFBGTOLUPHZARYIDNMWCJV
TGQKEPSYRLZBNHXOCWMMUVTQPKADGJSIEZRYNBFXLHWOTMVRKPUGJDCZIYBQWAHSOLXFUMEVYCTNBGJZRKDPQLIQWHAONVSYXUCJZBIFGRDK
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TXSYAIHMBGRQDKJULFONCPVXWHIEOTYRSJBUZGAXLFMKQWYIRPNNDZVEJHCOSTBDUXNMLPZGJKRIQVAHFYEWSCNLBTOJXZUKMPVWDLGSNC
QORYEZFHJLUAKXVMPCTNSQJDYGWRLBAIFKXPHMUUVONZDJLWTVISUCQCGKYRAZPHEBOMXLNWQDKFTCPGSUIRVXMEZYQOBTNLNHJCWDAZRVU
KGOFIPXMNEYWSHJQDBLTFACKPVZOMSLURGYNIHXQWJTCVEDOKAFYLSBNMPHGZURWJOIEKCTYFLPXVAMRDQNHGKSIWOBLUZYVTCQFDJPMHR
XENGISBLRVPARQYLNXMFDJCBKZGSRWHTPEUYQAVCMXRWFLSNDHPGZTJQIBUKYOEYVMFWZJDLHCURPNTIGQKSYXOBELNWFHAJJZR
VQGMTKSYDIPCEUKBJLONHRFYAVTGXUQPSNMZIWRFDQVYEKBJHMMWPLGSGYTFANURIOXVCJLWKHPQMGZTEFDBNISVOYXQTCJAJULRZGMPBFBK
HNDVWYSIECLJOQAKTUPHXGZRVBOYMWLFJDPQIXTUSCHENRLWFKOMGAJDHZBIQPTYVXEKSMCBURLFGONJXTUQAZMSPYCJHRLKTWXVIQDGHQ
BYFNLJZVERMWPAGKXUNCXTFHDQBILGORPKYWAMNVELTXXSUJDBRZPHFGMOQWAKVIJNEXYDUPLZRTBQHMSCFLKZNVYXTAJWOGQEDBPUMRLHYC
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VLKRQPAFHDZMXEJORNBLGYJYKCAWTIVQZPMXOSLJCYBRNKFAGHTEVPDILUZMXYEQJRPHONSAAWKGLCDFBTUOIZPLMQRYHNJKEGSDFOBWXTAIV
CNZULJHMRKYGOEDPCQWBNSVXAGLUTJPMRYKDHFOLCIEZQXNUBTGWKAJPSDLMRQCYVBHTGWNIOFZWEAKMXRPLDCHYBQZGTVNASOEKWIUF
RLXPDYJHBQCNVGTZWKLXUEOJARDPBIVFYZNSQGHGTCJAKRWNOLMGVEUXBDPISZFTQJHCNMRLVWYUKOGZPIJBHDXCFMQYKRPLONUTVEAG
WLJSDNZBXITMORHKCVQPDUYEGFJLNSXIWKOADTBHMQVURCZPXNYITGLJKDHSOABWPEENVMCQYRXKFTUZPLNOBGWHDAEYJMRUCQSYXPXTFIZL
KGODHNBRVWAEUQJMYXFTVCLKPIRSDZOGNHBMXWLEYQUPTKDJCVRNHSMZAFIGLWODQBPEYURKNVXTJMJZCAFHOEBLWPKISYXOBELNWFHAJJZR
RCAFWPELGIYQXUZDOKMTBNRVJSCHQLPXFWYIZKOGMTJADNUSVBRLLHPCQYOZNEFKGTMXWDJHRIPULSBVACOLNYEQKJTGZWUDXMPHBRKIQYS
JNEVAFZLCGWBBDPOTNHMXYRFKUJLVZEOCXQINAGTHBDPRMWSJKFYUOLVICZQAXNRGHPMJOTKLUESBYVDWCFNQYZAKURMTHJVEGBXIPOLWCQ
SNURDYXLTKVAGJMFBIPOCDWREXLMYQSNUJTVKAFGODIYBZLHCPWRXMXNQESKVJFBGTOLUPHZARYIDNMWCJVJZGQKEPSYRLZBNHXOCWMMU
VTPQKADGJSIEZRYNBFXLHWOTMVRKPUGJDCZIYBQWAHSOLXFUMEVYCTNBGJZRKDPQLIQWHAONVSYXUCJZBIFGRDKMLTPQEYSHOWAUVNFXMLJKZ
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PVXWHIEOTYRSJBUZGAXLFMKQWYIRPNNDZVEJHCOSTBDUXNMLPZGJKRIQVAHFYEWSCNLBTOJXZUKMPVWDLGSNCQORYEZFHJLUAKXVMPCTNSQ
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KPVZOMSLURGYNIHXQWJTCVEDOKAFYLSBNMPHGZURWJOIEKCTYFLPXVAMRDQNHGKSIWOBLUZYVTCQFDJPMHRXENGISBLRVPARQYLNXMFDJCB
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VQGMTKSYDIPCEUKBJLONHRFYAVTGXUQPSNMZIWRFDQVYEKBJHMMWPLGSGYTFANURIOXVCJLWKHPQMGZTEFDBNISVOYXQTCJAJULRZGMPBFBKHNDVWYSIECLJOQAKTUPHXGZ
RVBOYMWLFJDPQIXTUSCHENRLWFKOMGAJDHZBIQPTYVXEKSMCBURLFGONJXTUQAZMSPYCJHRLKTWXVIQDGHQVNLJZVERMWPAGKXUNCXTFHDQBIL
GORPKYWAMNVELTXXSUJDBRZPHFGMOQWAKVIJNEXYDUPLZRTBQHMSCFLKZNVYXTAJWOGQEDBPUMRLHYCJWVNFOTOKXVQGSYARMZCBEPHUI
WLTXDJKOVAGRFPYNOQCSPHXOTMZLRKEJYVDUWGANIBTFCLZPSXHQRMUJOKGQDAWNVYXDTJSIKRYFXAXWNQHOUBVTGMEZPDLCCXJFYSRAGNQH
BMLVJDTXGKXAPXINXDJVQLRYTBHCOZMUSWGPQKLVEYDINUTYLSHRBJAQVNMWQVFLQNKVYUCDXEHIGMSJZTVMRLOFFQPKVYQDNLXMSICGNW
DUBTLFJYOQXKVRUZIDGHSBWLAEPTMYCJQFNOXVKZRHGLDSUPAETFYCBQMJORWLHISZKNVUXDGFPAYNRTJHBLOZMCQWEYSIPVFTRDGHXL
ANQZMBOJCUKVVVTSREYQLIFDNZHAGXJBRCPOTVWUMEQYLNKIDZXSANGBROFTCQWUPLZVYMDNXIKJFEHSACROGVJWBQDTMLUKYZXFPHVIDJE
GONBARCTMSWLQZJYUKNFGXPODHLVLEITCBQMSRXWUAZPLDNQVFNHJYBCTZGQKRAMSWFPLXJHYODUNEZVGTIKCUBXQDLMPAWJFSONRHKTI
ZUVLBGYFCPEQWJNLAKOSMDRTZFVUYHIXPBJCLGNQKWDZTEVSUXRALMHBOKNJCYPVITFWQZLEGMDSOXJCRYHANVBULKZFZPITGKWMCEXRQY
DVSNOUPLBJHAKZFYGEXMMWTORVJLUIBNSDCQKPHTROGLXFWMZVJYADEBNQISCTKULHRWGPYZOMVYJBQLDNUEXRSWTHKZMAPYOLNUXVQFRJI
GWDCDESBHXTMQOKNPUJLZYGQFODVWSXARHCKMBILTJEPNZUYWGFQXOQSLHPCRIJBTZMUADNEYOKLGMWFPXQJRLAZZDCTNHIUVYEKPSOGQM
FWLBRXUYZINJDOVHTMKCSFFVAXYZQNKGLWUJEDHRJJOIMSVBCQTZFKPDQAWYMXEJVGULOSBHNTZKIFYPPDCQNXTEVMJRWZHLGOAKSPBIDJY
CQLXVWNMEHTUZOSRKDGPHABFYJUKWQLZTCOEGIRNSHPMDXAJBFRZLUWEQGTONTYSIKXPCMWHODBFQXLGWEZTUJAPVSKRINYOHBMFQDRWR
GVUPTYZJAXOLNCHKEKIJSVYQFTUBDMPGNHXRLWCKOAZIESJYZFMAVCWPGTHRODQXSLNIBWEUVCYQKDLFMZPXJHRGONERMBIAOSKPUYCHQDWLRJN
FBPXETIMAGUZOJSKYLVPICRWHTXQDMNEFIULKGYBOJSKNPAHACTVEFOLQXZMWYUINDGBSRKJHAPTLXFONIWQBZDKURJEPVGMCYHSBAQLNTIX
FUQZVEJGKLDSCYNPHTRWBMVAVJZLKOQXIDGNURMWQPJFTKSLOEHXBZVYDAGUMQRCNIXLPJTHFKSOVZWCNTJBNGMRADJEPUXTISFVLQKZNIH
YMGBXPHJTDNARFVQHLUYKGWZEDXHSJIPABTVCMNOKWYFZQRLPHUIBCTDNEVQWXXAMSLKJPRYGBUZFHVOCYNTJBMWEKIALJYKXNBUAFWFPZJONQCIY
MKDXULVCEQIAZPYHTNFUJWMLRBGQXSVDPFOIHKYCFZWOLJRBADPUVGXNIMKSYQHTWZJFCEQKVOBRDGPUPNWCWIIHLYASVZMJEFQLOKNBPRD
XITJWUAQSYVOBLZEGCUMHKPNWTRFXIDQYJESNOBLGPKWAIRZCUHTFVXDJNMGLEPSOYQKHIZBWAVLPTUMSRGJNXCFCFYQDKVJWBHTIFGZOWU
PMCYLDTBQKSARXJYVHZFWLPIONMGUCYRXDSJETFBQNKAVPULRHWMZMICOGSJXLKQNFUBUYVTAPEMIZORCGXWTJHLQDVKSNYBUAFWFPZJONQCIY
MKRSHVLGBDXTUPJOAHFYVWKNRMEZSGBDQLPUCJITRXOKYWANVLTZPFQGBHDCYEUSMXLIWOTFVRNZPTXQJCGSOMDVHAKRLFUBIQEPZVWYXT
VKGMOSZLUHNACBDIPWTYJXRQFVMPULSOZGKADNHYBCQJMLTUIRWVGXSDKPAFYHTOZXLBJCWNIPGTYDUQFVEMLHROJWAKZSBCXUGILPVQN
DMFETOKJSWYHRLZPAQUCNVGIXDBTFOSMRHYJYKLPZDAGBWQZKLEFFYVZHXGRMDIOWTQJNFCBUKSZRQAVMPLWGDZJMETOKHFXJUCJUC
VTLRINYGWAVOMSKZEBLHQDFYJNPXUTCEIZKBHGSQQLVDWRYPJNFCUOXTAGKHLVYIJEZRQNSCWPMDFTGBXEKURYLNHTPAJWSQMDVDIZXURG
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GYJYKCAWTIVQZPMXOSLJCYBRNKFAGHTEVPDILUZMXYEQJRPHONSAAWKGLCDFBTUOIZPLMQRYHNJKEGSDFOBWXTAIVCNZULJHMRKYGOEDPCQW
BNSVXAGLUTJPMRYKDHFOLCIEZQXNUBTGWKAJPSDLMRQCYVBHTGWNIOFZWEAKMXRPLDCHYBQZGTVNASOEKWIUFMRLXPDYJHBQCNVGTZWKLX
UEOJARDPBIVFYZNSQGHGTCJAKRWNOLMGVEUXBDPISZFTQJHCNMRLVWYUKOGZPIJBHDXCFMQYKRPLONUTVEAGWLJSDNZBXITMORHKCVQPD
UYEGFJLNSXIWKOADTBHMQVURCZPXNYITGLJKDHSOABWPEENVMCQYRXKFTUZPLNOBGWHDAEYJMRUCQSYXPXTFIZLKGODHNBRVWAEUQJMYXFT

VCLKPIRSDZOGNHBMXWLEYQUPTKDJCVRNHSMZAFIGLWODQBPEYURKNVXTJMJZCAFHOEBLWPIGRUQXDYNSMVKTJHRCFAWPELGIYQXUZDOKMT
BNRVJSCHQLPXFYWIZKOGMTJADNUSVBRHLHPCQYOZNEFKGTMXWDJHRIPULSBVACOLNIEYQKJTGZWUDXMPHBRKIQYSJNEVAFZLZCGWBDPOTNHMX
YRFKUJLVZEOCXQINAGHTHBDPRMWSJKFYUOLVICZQAXNRGHPMJOTKLUESBYVDWCFNQYZAKURMTHJVEGBXIPOLWCQSNURDYXLTKVAGJMFBIPIH
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MTCKFNPAPUZYQDGHVINSOLMRXBTJYWUEZKIVNPLSFMDYBQGHRTARUOJXCZFWKLEPNVTSYAIHZMBGRQDKJULFONCPVXWHIEOTYRSJBUZGAXLF
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XCSUJDBRZPHFGMOQWAKVIJNEXYDUPLZRTBQHMSCLFKZNVYXTAJWOGQEDBPMURLHYCJWNFTOKXVQGSYARMZCBEPHUIWLTDXDKOVAGRFRY
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EZQXNUBTGWKAJPSDLMRCTVYBHTGNIQFZWUEAKMXRPLDJCHYBQZGTVNASOEKIWIUFMRXPDPYJHBQCNVGTZWKLXUEQJARDPBIVFYZNSQGHTECJ
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PHBRKIQYSJNEVAFZLZCGWBDPOTNHMXYRKFUJLVZEOCXQINAGHTHBDPRMWSJKFYUOLVICZQAXNRGHPMJOTKLUESBYVDWCFNQYZAKURMTHJVEG
BXIPOLWCQSNURDYXLTKVAGJMFBIPIHOCDWREXLMYQSNJUTJVKAFGODIYBZLHCPWRXNMNQUESKVJFBGTOLUPHZARYIDNMWCJVTGQKEPSYRLZBN
HXOCWMUVTQPKADGJSIEZRYNBFXLHWOTMVRKJPGJDCZIYBQWAHSOLXFUMEVYCTNBGJZRKDPLIQWHAONVSXYUCJZBIFGRDKMLTPQEYSHOWA
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HJQDBLTFACKPVZOMSLURGYNIHXQWJTJCEVEDOKAFYLSBNMPHGZURWJOIEKCTYFLPXVAMRDQNHGKSIWOBLUZYVTCQFJPMHRXENGISOLBZWKA
UTVPRQYLNXMFDJCBIKZGSROWHTEPUYQAVCMXRWFLSNDHPGZTJQIBUKYOEXVMFWZJDALHCURPNTIGQKSYXOBELNWFHAJZRVQGMTKSYDIPCEUKBJLONHRFYAVTGXU
UKBJLONHRFYAVTGXUQPSNMZIWRFDVYEKBQJHMMWPLGSGYTZFANURIOXVCJLWKHPQMGTFZFDNBISVOYXQTCJAJULRZGMPBKFHNDVWYSIECLJO
QAKTUPHXGZRVBOBYMWLJDPQIXTUSCHENRLWFKOMGAJDHZBIQPTYVXEKSMCBURLFGONJXTUQAZMSPYCJHRLKTWXVIQDHGOBYFNJLZVERMWPA
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GSDYARMZCBEPHUIWLTDXDKOVAGRFRYNQCSPHXOTMZLKEJYVDUWGANIBTFCLZPSXHQRMUJOKGQDAWNVYXMQYKRPLONUTVEAGWLJSDNBXBI
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WAEUQJMYXFTVCLKPIRSDZOGNHBMXWLEYQUPTKDJCVRNHSMZAFIGLWODQBPEYURKNVXTJMJZCAFHOEBLWPIGRUQXDYNSMVKTJHRCFAWPEL
IYQXUZDOKMTBNRVJSCHQLPXFYWIZKOGMTJADNUSVBRHLHPCQYOZNEFKGTMXWDJHRIPULSBVACOLNIEYQKJTGZWUDXMPHBRKIQYSJNEVAFZLZCG
WBDPOTNHMXYRKFUJLVZEOCXQINAGHTHBDPRMWSJKFYUOLVICZQAXNRGHPMJOTKLUESBYVDWCFNQYZAKURMTHJVEGBXIPOLWCQSNURDYXLTK
KVAGJMFBIPIHOCDWREXLMYQSNJUTJVKAFGODIYBZLHCPWRXNMNQUESKVJFBGTOLUPHZARYIDNMWCJVTGQKEPSYRLZBNHXOCWMUVTQPKADGJSI
EZRYNBFXLHWOTMVRKJPGJDCZIYBQWAHSOLXFUMEVYCTNBGJZRKDPLIQWHAONVSXYUCJZBIFGRDKMLTPQEYSHOWAUVNFXMLJKZITCRGSPV
BQDOHWRLXJEMTCKFNPAPUZYQDGHVINSOLMRXBTJYWUEZKIVNPLSFMDYBQGHRTARUOJXCZFWKLEPNVTSYAIHZMBGRQDKJULFONCPVXWHIEOT
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URGYNIHXQWJTJCEVEDOKAFYLSBNMPHGZURWJOIEKCTYFLPXVAMRDQNHGKSIWOBLUZYVTCQFJPMHRXENGISOLBZWKAUTVPRQYLNXMFDJCBIKZ
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PSNMZIWRFDVYEKBQJHMMWPLGSGYTZFANURIOXVCJLWKHPQMGTFZFDNBISVOYXQTCJAJULRZGMPBKFHNDVWYSIECLJOQAKTUPHXGZRVBOBYMWL
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VFCRJWQYEHANXOGUBVPLCMZDTJSIKRYFAWNQHOUBVTGMEZPDLXJFYSYRAKNGQHBMLVJOTXWIZPKFECUYPDVNSRHLQKAPXTJWOGVECID
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WHIGVQNOZDZTUSREJBPLKFAYMCUNQJZXGVDIHPWTROKLSBFAYJENUXZVLTIKPDHQMWBBCROFNJGSLAYKTVDHMPNZQFWBBIROUCXLEGVHSJZPA
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BXIPOLWCQSNURDYXLTKVAGJMFBIPIHOCDWREXLMYQSNJUTJVKAFGODIYBZLHCPWRXNMNQUESKVJFBGTOLUPHZARYIDNMWCJVTGQKEPSYRLZBN
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UVNFXMLJKZITCRGSPVYPBQDOHWRLXJEMTCKFNPAPUZYQDGHVINSOLMRXBTJYWUEZKIVNPLSFMDYBQGHRTARUOJXCZFWKLEPNVTSYAIHZMBGRQDKJULFONCPVXWHIEOTYRSJBUZGAXLFMKQWYIRPNDZVEJHCOSTBDUXNMLPZGJKRIQVAHFYE

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RVXMEZOYQJBTLNCJWDADZRVUKGOFIPXMNEYWSHJQDBLTFACKPVZOMSLURGYNIHXQWJTCVEDOKAFYLBNSMPHGZURWJOIEKCTYFLPXVAMRDQ
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QAZMSPYCJHRLKTXWVIQDGHGOBYFNJLZVERMWPAKSUNCXTFHDQBIJLGORPKYWAMNVELTXCSUJDBRZPHFGMOQWAKVIJNEXYDUPLZRTBQHMSCL
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ZPLMQRYHNHJKEGSDFOBWXTAIVCNZULJHMRKYGOEDPCQWBNSVXAGLUTJPMRYKDHOLFOLCIEZQXNUBTGWKAJPSDLMRVCYBHTGNIOFZWUEAKMXR
PLDJCHYBZGZGTVNASOEKWIUFMRLXPDYJHBQCNVGTZWKLXUUEOJARDPBIVFYZNSQGHCTJAKRWNOLMGVEUXBDPISZFTQJHCNMRLVWYUOKOGZP
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JVTGQKEPSYRLZBNHXOCWMUVTQPKADGJSIEZRYNBFXLHWOTMVRKPUJGDCZYBQWAHSOLXFUMEVYCTNBGJZRKDPDQIQAHAONVSYXUCJZBIFGR
DKMLTPQEYSHOWAUUVNFXFMLJKZITCRGSPVYBQDOHWRLXJEMTCKFNPAUZQYDGHVSINOLMRXBTJYWUEZKIVNPLSFMDYBQGHTARUOJXCZFWKLEPNVXTS
NVTXSAIHZMBGRQDKJULFONCPVXWHIEOTYRSJBUZGAXLFMKQWYIRPNZVEJHCOSTBDUXNMPLZGJKRIQVAHFYEWWSCLNBTOJXZUKMPVWDLGS
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EXRSWTHKZMAPYOLNUXVQFRJIGWCDESBBXTMQOKNPLJLZYGQFODBVWSXARHCBMILJTJEPNZUYWGFQOVSLHPCRJIBTQMADNEYOKLGVHMFPP
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XJHRGONBIAOSKUYCHQDWLJRJNFBXPETIMAGUZOJSKYLVPCRWHXTQDMNEFIULKGYBOJSKNPRAHCTVEFOLQXZMMWYUINDGBSRKJHAPTLXFONIW
QBZDKURJEPVGMCYHSBAQLNTIXFUQZVEJGKLDSYCNPHTRUWMAVZJLZKQXIDGNURMWMPQJFTKSLOEHBZVYDAGUMQRCNIXLPJTHFKSOVZWQCY
BNGMGRYFEXUPTISFVLQKZKNHCYMGBXPJHTDNARFVQQLUYKGVWZDVTVMNOXWFFYZQRLPHUIBCTZGQWAXMSLKJPRYGBZHUJFVOCN
TJMXWEKIALYSRPHOQFVGNB TJZMKDXULVCEQIAZPYHTNFUJWMLRBGQXSVDPEDIOHKYZCFWOLJRBADPUVGXNIMKSYQHTWZJFCEQKVQBOBRDGP
NCWXIHFLAYSVMZJEFQLOKNBPRDXITJWUAQSYVOBLZEGCUMHKPNWTRFXIDQYEJSNOBLGPKWAIKZCUHTFVXDJNMGLEPSOYQKHIZBWAVLPTUMSR
GJNXCETQYDKVJWBHTIFGZOWUPMPCYLDTBQKSARXJVHZFWLPIONMGOCYRXDSJETFBQNKAVPULRHWZMICOGSJXLKQNFUBUYVTAPEMIZORCGXWT
JHLQDVKSNYBUAFWPZJONQCIYMKRSHVLGBDXTUPJOAHFYVWKNRMEZSGBDQLPUCJITRXOKYWANVLZTPFGQJBHDCYEUSMXLIWOTFVRNZPTXQJ
CGSOMDVHAKRFLUBIQEPZWYXTVKGMOSZLUHNACBDIPWTYJXRQYFVMPULSOZGKADNHYBCQEJMLTUIRWVGXSDKPAFYHTOZXLBJCWNIPGTYDUQF
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KTMVLVKRQPAFHDZMXEUORNBLGYKCAWTIVQZPMXOSLJCYBRNKFAGHTEVPDILUZMSEYQJRPHONSAAWKGLCDFBTUOIZPLMQRYHNHJKEGSDFOBW
TAIVCNZULJHMRKYGOEDPCQWBNSVXAGLUTJPMRYKDHOLFOLCIEZQXNUBTGWKAJPSDLMRVCYBHTGNIOFZWUEAKMXRPLDJCHYBZGZGTVNASOEKWI
UFMRLXPDYJHBQCNVGTZWKLXUUEOJARDPBIVFYZNSQGHCTJAKRWNOLMGVEUXBDPISZFTQJHCNMRLVWYUOKOGZP
AGWLJSDNZBITMORHKCVQPDUEYEGFJLNSXIWKOADTBHMQVURCZPXYNITGLJKDHSOABWPENVMQCYRXKFTUZPLNOBGWHDAAEVJMRUCQSYPTFI
ZLKGODHNBRVWAEUQJMYXFTVCLKPIRSDZOGNHBMXWLEYQUPTKDJCVRNHSMZAFIGLWODQBPEYURKNVXTJMZCAFHOEBLWPIGRUQXDYNMVKTH
JRCAFWPELGIYQXUZDOKMTBNRVJSCHQLPXFYVIZKOGMTJADNUSVBRLLHPCQYOZNEFKGTMXWDJHRIPULSBVACOLNVEQKJTGZGWUDXMPHBRKI
YSJNEVAFZLCGWBBDPOTNHMXYRKFUJLVZEOCXQINAGTHBDPRMWSJKFYUOLVICZQAXNRGHPMJOTKLUESBYVDWCFNQYZAKURMTHJVEGBXIPOLW
CQSNURDYXLTKVAGJMFBIPOCDWREXLMYQSNUJTVKAFGODIYBZLHCPWRXNMNQESKVJFBGTOLPHZARYIDNMWCJVTGQKEPSYRLZBNHXOCWM
UVTQPKADGJSIEZRYNBFXLHWOTMVRKPUJGDCZYBQWAHSOLXFUMEVYCTNBGJZRKDPDQIQAHAONVSYXUCJZBIFGRDKMLTPQEYSHOWAUUVNFXFML
JKZITCRGSPVYBQDOHWRLXJEMTCKFNPAUZQYDGHVSINOLMRXBTJYWUEZKIVNPLSFMDYBQGHTARUOJXCZFWKLEPNVXTS
NVTXSAIHZMBGRQDKJULFONCPVXWHIEOTYRSJBUZGAXLFMKQWYIRPNZVEJHCOSTBDUXNMPLZGJKRIQVAHFYEWWSCLNBTOJXZUKMPVWDLGSNCQORYEFZFHJLUAKXVMPCTNSQJDYGWRLBAIFKXPHMUUVONZDJLWTVISUCQKGKYRAZPHEBOMXLNWQDJKFTCPGSUIRVXMEZOYQJBTLNCJWDADZRVUKGOFIPXMNEYWSHJQDBLTFACKPVZOMSLURGYNIHXQWJTCVEDOKAFYLBNSMPHGZURWJOIEKCTYFLPXVAMRDQNHGKSIWOBLUZYVTCQFDDJPMHRXENGISOLBZWKAUTVPRQYLNXMFDJCBIKZGSROWHTEPUYQAVCMXRWFLSNDHPGZTJQIBUKYOEXVMFWZJDALHCURPNTIGQKSYXOBELNWFHAJZRVQGMTKSYDIPCEUKBJLONHRFYAVTGXUQPSNMZIWRFDVOVEYKQBQJHMMWPLGSGYTFZANURIOXVCJLWKHPQMGTZEFDNBISVOYXQTCJAULRZGMPBFBKHNDDVWYSIECLJOQAKTUPHXGZRVBOYMWLWJDPQIXTUSCHENRLWFKOMGAJDHBIQPTYVYXEKSMCBURLFGONJXTUQAZMSPYCJHRLKTXWVIQDGHGOBYFNJLZVERMWPAKSUNCXTFHDQBIJLGORPKYWAMNVELTXCSUJDBRZPHFGMOQWAKVIJNEXYDUPLZRTBQHMSCLFKZNVYXTAJWOGQEDBPUMRLHYCJIWNFTOKXVQGS DYARM

XENGISOLBZWKAUTVPRQYLNXMFDJCBKIZGSROWHTEPUYQAVCMXRWFLSNDHPGZTJQIBUKYOEYVMFWZJDALHCURPNTIGQKSYXOBELNWFHJZR
VQGMTKSYDIPCEUKBJLONHRRFYAVTGXUQPSNMZWRFDVOYEKBQJHWMFLSDHSYTFZANURIOXVCJLWKHPQMGZTEFDNBISVOYXQTCJAULRZGMPBFK
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KGODHNBRVWAEUQJMYXFTVCLKPIRSZOGNHBMXWLEYQUPTKDJCVRNHSMZAFIWLWODQBPEYURKNVXTJMZCAFHOBELWPIGRUQXDYNYSMVKTJH
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YAVTGXUQPSNMZWRFDVOYEKBQJHWMFLSDHSYTFZANURIOXVCJLWKHPQMGZTEFDNBISVOYXQTCJAULRZGMPBFKHNDDVWYSIECLJQOAKTUPHXGZ
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EOTYRSJBUZGAXLFMKQWYIRPNDZVEJHCOSTBDUXNMPLPZGJKRIQVAHFYEWSCNLNBTOJXZUKMPVWDLGSNQCQORYEZFHJLJLUAKVMPCTNSQJDYGW
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JWRZTLCKGKHAPXINXDJVQLRYTBHCOZMUSWGPQKLVEXYDINURTJHAMBGCSSOWFPLQNKVYUCUDXEHIGMSJZTWBRLFOFPQKVEHXJAYZRMISICGNW
DUBTLFJYOQXKVRUZNIDGHSBWLAEPTMYCJQFNOXVKZRHLGDSUPAETFYCBQMJORWLHISZNVUXDGGFPAYNRTJHBLZOMCQWEYKSIPIVFTRDGHXL
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GONBARCTMSWLQZJYUKNFGXPODHVLEITCBQMSRXWUAZPLDNQOFVKEHJJIYBCTZGQKRAMSWFPLXJHYODUNEZVGTKICUBXQDLMPAWJFSONRHKTI
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GWCDSEBHTXMQQKNPUJLZYGFODVWSXARHCKMBILTJEPNZUYWGFQXQVLSLHPCRIJBTZMUADNEYOKLGMWFPXQJRBZLADZCTNHIUVYEKPSOGQM
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VKGMOSZLUHNAACBDIPWTYJXRQFVMPULSOZGKADNHYBCQJMLTUIRWVWGXSDKPAFYHTOZXLBJCWNIPGTYDUQFVEMLHRIJWAKZSBXCUGLFPVN
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HJQDBLTFACKPVZOMSLURGYNH XQWJTCVEDOKAFY LBSNMPHGZURWJOIEKCTYFLPXVAMRDQNHGKSIWOBLUZYVTCQFDJPMHRXENGISOLBZWK
UTVPRQYFLNXMFJDCBIKZGSRWHTPEUYQAVCMXRWFLSNDHPGZTJQIBUKYOE XVMFWZJDALHLCURPNTIGQKSYXOBELNWFHJZRVQGMTKSYDIPCE
UKBJLONHRFYAVTGXUQPSNMZIWRFDOVYEKBQJH MWPLGSGYSZFANURIOXVCJLWKHPQMG TZEFDNBISVOYXQTCJAULRZGMPBFK HNDVWYSIECLJO
QAKTUPHXGZRV OBYMWLFJDPQIXTUSCHENRLWFKOMGAJDHZBIQPTYVYXEKSMCBURLFGONJXTUQAZMSPYCJHRLKTWXVIQDHGOBYFNJLZVERMWP
AKSUNCXTFHDQBIJLGORPKY WAMNVELT XCSUJDBRZPHFGMOQWAKVIJNEXYDUPLZRTBQHMSCLFKZNVYXTAJWOGQEDBPUMLRHYCJWNFTOKXVQ
GSDYARMZCBEPHUIWLT XDJKOVAGRFRYNQCSPHXOTMZLRKEJYVDUWGANIBTFCLZPSXHQRMUJOKGQDAWNVYXMQYKRPLONUTVEAGWLJSDNZBXI
TMORHKCVQPDYUEGFLJNSXWKOADTBHMQVURCZPXNYITGLJKDHSOABWPENVMQCYRXKFTUZPLNOBGWHD AEVJMR CUQSYPTFIZLKGODHNBREL
WAEUQJMYXFTVCLKPIRSDZOGNHBMXWLEYQUPTKDJJCVRNHSMAZFIGLWODQBPEYURKNVXTJMJZCAFHOBELWPIGRUQXDY
IYQXUZDOKMTBNRVJSC HQLPXFWYIZKOGMTJADNUSVBR LHPCQYOZNEFKGTMXW DJHRIPULSBVACOLNIEYEQKJTGZWUDXMPHBRKIQYSJNEVAFZLGC
WBDPOTN HMX YRFKUJLVZEOCXQINAGTHB DPRMWSJKFYUOLVICZQAXNRGHPMJOTKLUESBYVDWCFNQY ZAKURMTJHJVEG BXIPOLWCQSNURDYXL
TKVAGJMFBIPOCDWREXLMYQSNUJTVKAFGODIYBZLHCPWRX MNQESKVFJFBGT OULPHZARYIDNMWCJV TGQKEPSYRLZBNHXOAHWSOLXFUMEVYCTNBGJZRKDPLIQWHAONVSYXUCJZBIFGRDKMLTPQEYSHOWA
EZRYNBFXLHWOTMVRKPUGJDCZIYBQWAHSOLXFUMEVYCTNBGJZRKDPLIQWHAONVSYXUCJZBIFGRDKMLTPQEYSHOWAUVN X FMLJKZITCRGSPVY
BQDOHWRLXJEMTCKFNPAUZQYDGHVSNOLMRXBTJYWUEZKIVNPLSFMDYBQGH TARUOJXCZFWKLEPNVTXSYAIH ZMBGRQDKJULFONCPVXWHIEOT
YRSJBUZGAXLFMKQWYIRPNDZVEJHCOSTBDUXNMLPZGJKRIQVAHFYEWSCNLBTOJXZUKMPVWDLGNSCQORYEZFHJLUAKXVMPCTNSQJDYGWRLB
AIFKXPHMUVONZDJLWTVISUCQKGK YRAZPHEBOMXLNWQDJKFTCPGSUIRVXMEZYOQBTNLHJCWDAZRVUKGOFIPX MN EYWSHJQDBLTFACKPVZOMSL
URGYNH XQWJTCVEDOKAFY LBSNMPHGZURWJOIEKCTYFLPXVAMRDQNHGKSIWOBLUZYVTCQFDJPMHRXENGISOLBZWKAUTVPRQYFLNXMFJDCBIKZ
GSRWHTPEUYQAVCMXRWFLSNDHPGZTJQIBUKYOE XVMFWZJDALHLCURPNTIGQKSYXOBELNWFHJZRVQGMTKSYDIPCEUKBJLONHRFYAVTGXUQPSNMZIWRFDOVYEKBQJH MWPLGSGYSZFANURIOXVCJLWKHPQMG TZEFDNBISVOYXQTCJAULRZGMPBFK HNDVWYSIECLJOQAKTUPHXGZRV OBYMWLFJDPQIXTUSCHENRLWFKOMGAJDHZBIQPTYVYXEKSMCBURLFGONJXTUQAZMSPYCJHRLKTWXVIQDHGOBYFNJLZVERMWP
PSNMZIWRFDOVYEKBQJH MWPLGSGYSZFANURIOXVCJLWKHPQMG TZEFDNBISVOYXQTCJAULRZGMPBFK HNDVWYSIECLJOQAKTUPHXGZRV OBYMWLFJDPQIXTUSCHENRLWFKOMGAJDHZBIQPTYVYXEKSMCBURLFGONJXTUQAZMSPYCJHRLKTWXVIQDHGOBYFNJLZVERMWP
PKSUNCXTFHDQBIJLGORPKY WAMNVELT XCSUJDBRZPHFGMOQWAKVIJNEXYDUPLZRTBQHMSCLFKZNVYXTAJWOGQEDBPUMLRHYCJWNFTOKXVQ
GSDYARMZCBEPHUIWLT XDJKOVAGRFRYNQCSPHXOTMZLRKEJYVDUWGANIBTFCLZPSXHQRMUJOKGQDAWNVYXTPBZSLMIROZPNWYMBAKTIVDQHGLSUFEXJCRNZPBVOJHK
DFGUMXAWRELTYQCN SIDMBZPWOKQNRJFAVSTYXLC DIEGUBPHKZOMT WQRDLXJAVFCENYUISGBZPLTWOMQXKDFVRJHACGYENUSIZBKOPXMTDL
VFCRJJWQEYHANXOGUBPLCMZDTJSIKRYFXAWNHOUBVTGMEZPDLCLXJFZAGKNQGHMBLVJOTXWIZPKFEFCUYDVNSRHBLQKAPXTJWOGZMEVID
UNFYLSHRBJAXWNQIKQVMZGTPYDELCSUVJHRBYLXWACPOKZMNFTGIDUEQVYSHPXJBLORNTKWZFAVMCUEYIHXQDPLGJLSNZOTVBRMFYAKLCXP
WHIGVQNO DZTUSREJBLKFAYMCUNQJZXGVDIHPWTROKLSBFAYJENUXZVLTIKPDHQMWBRCOFNGJSLAYKTVHDMPNZQFWBIROUCLXLEGVHSJZPA
QMWRYKDBFLNXTOVIGQGCHUJZSWPYAXMDQKLBFTONVJCEIRHXUZJGLPNMBDSOVFGUJWRZTL CGKHAPXINXDJVQLRYTBHCBOZMWSWGPFQKLVE
YDINUR TJHAMBGC SZOWFPLQNKVY CUDXEHI GMSJZTWBRLOFPQKVEXHJAYZ RMSICGNWDUBTLFJYOQXKVRUZNI DGH SBWLAEPTMYCJQFN OXVKZR
HGLDSUPAETFCBQMJORWLHISZNKVUXDGFPAYNRTJHBL OZMCQWEYKSIPTVTRDGHXLANQZMBOJC UKWVTSREYQLIFDNZHAGXJBR CPTOVWUME
GLXFWMZVJYADEBNQISCTKULHRWGYPZOMVFBQDLNUEXRSWTHKZMAPYOLNUXVQFRJIGWCD ESBHXTMQQKNPUJLZYQGODVWXSARHXKMBILT
JEPNZUYWGFQXQOVS LHPCRJIBT ZMUADNEYOKL GWMFPXQRJBLAZDCTNHIUVY EKP SOGQMFWLBRXUYZINJDVOHTMCKSFVPVAXYQZNKGLWUEDHRJO
IMSVBCQTZFKPDQAWYMXEJVGULOSBHNT RZKIFPDCQNXTEVMJRWXZHLGOAKSPBDIFJYQCLXVWNMEHTUZOSRKDGPHABFYJUKWQLZTCOEGRIN
SHVPMDXAJBFRZLUWDEBQFXTGTONYSIKXPCMVHODBFQXGLGWEZTUAPJVRSHRYNOLXUVQFRJIGWCD ESBHXTMQQKNPUJLZYQGODVWXSARHXKMBILT
ZESJYZFMAVKPGTHRODQXSLNIBWEUVCYTQKDLFMZPXJHRGONBIAOSVKUYCHQDWLRJNFBXPETIMAGUZOJSKYLVPCRWHYTXQDMNEFIULKGYBOJS
KNPRAHCTVEFOLQXZMWYUINDGBSRKJHAPTLX FONIWOQBZDKURJEPVGM CYHSBAQLNTIXFUQZVEJGKLDSCYNPHTRWBMVAVJZLKOQXIDGNURMWPQ
JFTKSLIOEHXBZVYDAGUMQRCNIXLPJTHFKSOVZWCYCBNGMRADJBDPXTISFVLWQKZCNH CYMGBXPJHTDNARFVQLUYKAPXTJWOGZMEVID
WFFYZQRLPHUIBCTDNEVQWXAMSLKJPRYGBUZFHVOCNTJMXWEKIALYSRPHQOQFVGNBTJZMKDXULVCEQIAZPYHTNFUJWMLR BGQXSVDPEOIHKYZC
FWOLJRBADPUVGNXIMKSYQHTWZJFCEQKVOBRDGPUTNCWIXHLAYSVMZJEFQLOKNBPRDXITJWUAQSYVOBLZEGCUMHKPNWTRFXIDQY EJSNOBLG
PKWAMJLZUIRWXGSDQKPAFYHTOZXLBJCWNIPGTYDUQGFVEMLRHNTAPJVRSHRYNOLXUVQFRJIGWCD ESBHXTMQQKNPUJLZYQGODVWXSARHXKMBILT
KAVPULRHWZMICO GSGJLXKQNFUBVYTAPEMIZORCGXWTJHLQDVKSNYBUAFWPZJONQCIYMKRSHVLGBDXTUPJOAHFYVWKNRMEZSGBDQLPUCJITR
XOKYJWANVLTPZFPFGQJBHDCYEUSMXLIWOTVRNZPTXQJCGSOMDVHAKRLFUBIQEPZWYXTVKGMOSZLUHNACBDIPWPTYJXRQFVMPULSOZGKADNHY
BQCEJMLTUIRWXGSDQKPAFYHTOZXLBJCWNIPGTYDUQGFVEMLRHNTAPJVRSHRYNOLXUVQFRJIGWCD ESBHXTMQQKNPUJLZYQGODVWXSARHXKMBILT
AGBWQXJXCUNKLTLEFPYVZHXGRMDIOWTQJNFCBUKSZRQAVMPLIWGDYETOKHFXBJUCQPQVTLRINYGWAVOMSKZEBLHQDFYJNPXUTCEIZKHBGSQLV
DWRYPJNFCUOXTAGKHLTYIJEZRQNSCWPMDFO TGBXEKURYLNHPTAJWVXSMQMDVIZURGHJYFCNBQKPWTEAVLMRSDIZOKBGQWJTXCYCNPLDHURE
AVGFOYMSJAJBFRZLUWDEBQFXTGTONYSIKXPCMVHODBFQXGLGWEZTUAPJVRSHRYNOLXUVQFRJIGWCD ESBHXTMQQKNPUJLZYQGODVWXSARHXKMBILT
QJRPHONSAWKGCLCDFBTUOIZPLMQRYHNJKEGSDFOBWXTAIVCNZULJHMRKYGOEDPCQWBNSVXAGLUTJPMRYKDH FOLCIEZQXNUBTGWKAJPSDL
RCVYBHTGNIOFZWUEAKMXRPLDJCHYBQZGTVNASOEKIUFMRLXPDYJHBQC NVGTZWKL MXUEOJARDPBIVFYZNSQGHGTCJAKRWNOLMGVEUXBDPIS
ZFTQJHCNMRLVWVYUOKGZPIJBDHXCFLLEYUPTKDJJCVRNHSMAZFIGLWODQBPEYURKNVXTJMJZCAFHOBELWPIGRUQXDY
BWPENVMQCYRXKFTUZPLNOBGWHD AEVJMR CUQSYPTFIZLKGODHNB RVWAEUQJMYXFTVCLKPIRSDZOGNHBMXWLEYQUPTKDJJCVRNHSMAZFIGL
WODQBPEYURKNVXTJMJZCAFHOBELWPIGRUQXDYNSMVKTJHRCFAWFPELGIYQXUZDOKMTBNRVJSC HQLPXFWYIZKOGMTJADNUSVBR LHPCQYOZNE
FKGTMXW DJHRIPULSBVACOLNIEYEQKJTGZWUDXMPHBRKIQYSJNEVAFZLGCWBDPOTN HMX YRFKUJLVZEOCXQINAGTHB DPRMWSJKFYUOLVICZQAX
NRGHPMJOTKLUESBYVDWCFNQY ZAKURMTJHJVEG BXIPOLWCQSNURDYXLTKVAGJMFBIPOCDWREXLMYQSNUJTVKAFGODIYBZLHCPWRX MNQESK
VFJFBGT OULPHZARYIDNMWCJV TGQKEPSYRLZBNHXOAHWSOLXFUMEVYCTNBGJZRKDPLIQWHAONVSYXUCJZBIFGRDKMLTPQEYSHOWA
UUVNXFMLJKZITCRGSPVYPBQDOHWRLXJEMTCKFNPAUZQYDGHVSNOLMRXBTJYWUEZKIVNPLSFMDYBQGH TARUOJXCZFWKLEPNVTXSYAIH ZMBGRQ
DKJULFONCPVXWHIEOTYRSJBUZGAXLFMKQWYIRPNDZVEJHCOSTBDUXNMLPZGJKRIQVAHFYEWSCNLBTOJXZUKMPVWDLGNSCQORYEZFHJLUAK
XVMPCTNSQJDYGWRLBAIFKXPHMUVONZDJLWTVISUCQKGK YRAZPHEBOMXLNWQDJKFTCPGSUIRVXMEZYOQBTNLHJCWDAZRVUKGOFIPX MN EYWS
HJQDBLTFACKPVZOMSLURGYNH XQWJTCVEDOKAFY LBSNMPHGZURWJOIEKCTYFLPXVAMRDQNHGKSIWOBLUZYVTCQFDJPMHRXENGISOLBZWK
UTVPRQYFLNXMFJDCBIKZGSRWHTPEUYQAVCMXRWFLSNDHPGZTJQIBUKYOE XVMFWZJDALHLCURPNTIGQKSYXOBELNWFHJZRVQGMTKSYDIPCE
UKBJLONHRFYAVTGXUQPSNMZIWRFDOVYEKBQJH MWPLGSGYSZFANURIOXVCJLWKHPQMG TZEFDNBISVOYXQTCJAULRZGMPBFK HNDVWYSIECLJO
QAKTUPHXGZRV OBYMWLFJDPQIXTUSCHENRLWFKOMGAJDHZBIQPTYVYXEKSMCBURLFGONJXTUQAZMSPYCJHRLKTWXVIQDHGOBYFNJLZVERMWP
AKSUNCXTFHDQBIJLGORPKY WAMNVELT XCSUJDBRZPHFGMOQWAKVIJNEXYDUPLZRTBQHMSCLFKZNVYXTAJWOGQEDBPUMLRHYCJWNFTOKXVQ
GSDYARMZCBEPHUIWLT XDJKOVAGRFRYNQCSPHXOTMZLRKEJYVDUWGANIBTFCLZPSXHQRMUJOKGQDAWNVYXTPBZSLMIRGTMVLKRQPAFH DZMXE
UORNBLGYJYCAWTVQZPMXOSLJCYBRNKFAGHTEVPDILUZMXEYQJRPHONSAWKGCLCDFBTUOIZPLMQRYHNJKEGSDFOBWXTAIVCNZULJHMRKYGOEDPCQWBNSVXAGLUTJPMRYKDH FOLCIEZQXNUBTGWKAJPSDL
RCVYBHTGNIOFZWUEAKMXRPLDJCHYBQZGTVNASOEKIUFMRLXPDYJHBQC NVGTZWKL MXUEOJARDPBIVFYZNSQGHGTCJAKRWNOLMGVEUXBDPIS
ZFTQJHCNMRLVWVYUOKGZPIJBDHXCFLLEYUPTKDJJCVRNHSMAZFIGLWODQBPEYURKNVXTJMJZCAFHOBELWPIGRUQXDYNSMVKTJHRCFAWFPELGIYQXUZDOKMTBNRVJSC HQLPXFWYIZKOGMTJADNUSVBR LHPCQYOZNE
FKGTMXW DJHRIPULSBVACOLNIEYEQKJTGZWUDXMPHBRKIQYSJNEVAFZLGCWBDPOTN HMX YRFKUJLVZEOCXQINAGTHB DPRMWSJKFYUOLVICZQAXNRGHPMJOTKLUESBYVDWCFNQY ZAKURMTJHJVEG BXIPOLWCQSNURDYXLTKVAGJMFBIPOCDWREXLMYQSNUJTVKAFGODIYBZLHCPWRX MNQESKVFJFBGT OULPHZARYIDNMWC

YEKBQJHMMWPLGYSYTFANURIOXVCJLWKHPQMGZTEFDNBISVOYXQTCJAULRZGMPBFKHNDVWYSIECLJOQAKTUPHXGZRVBOBYMWLFJDPQIXTUSCH
ENRLWFKOMGAJDHZBIQPTYVYXKSMCBURLFGONJXTUQAZMSPYCJHRLKTWXVIQDHGOBYFNLJZVERMWPAKSUNCXTFHDQBILGORPKYWAMNVELT
XCSUJDBRZPHFGMOQWAKVIJNEXYDUPDLZRTBQHMSCLFKZNVYXTAJWOGQEDBPUMRLHYCJIWNFTOKXVQGS DYARMZCBEPHUIWLTXDJKOVAGR FY
NQCSPHXOTMZLRKEJYVDUWGANI BTCLZPSXHQRMUJOKGQDAWNVYXTPBZSLMIROZPNWY MBAKTIVDQHGLSUFXEJCRNZPBVOJHKDFGUMXAWRE
LTYQCNSIDBMZPWOKQNRJFAVSTYLXCDIEGUBPHKZOMTWQRLDXJAVFCENYUISGBZPLTWOMQKXDFVRJHACGYENUSIZBKOPXMTDLVFCRJWQ EYH
ANXOGUBVPLCMZDTJJSIKRYFXAWNQHOUHVBTGMEZPDL CXJFSYRAKNGQHBMLVJOTXWIZPK EFCUYDVNSRHBLQKAPXTJWOGZMEVCIDUNFYLSHRBJ
AXWNOIKQVMZGTPYDEL CFSUVJHRBYLXWACPOKZMNFTGIDUEQVYSHPXJBLORNTKWZFAVMCUIEIHQXDPGLJSNZOTVBRMFYAKLCXPWHIGVQ NOD
ZTUSREJBPLKFAYMCUNQJZXGVDIHPWTROKLSBFAYJENUXZVLTIKPDHQMWBRCROFNGJSLAYKTVHDMPNZQFVBIROUCXLEGVHSJZPAQMWR YKDBF
LNXTOVIGQCHUJZSWPYAXMDQKLBFTONVJCEIRHXUZYGLPNMBDSOVFQJ JWRZTL CGKHAPXINXDJVQLRYTBHCOZMUSWGPFQKLVEXYDINUR TJHAM
BGCSZOWFPLQNKVYCUDXEHIGMSJZTWBRLOFPQKVEXHJAYZRM SICGNWDUBTLFJYOQXKVRUZ NIDGHSBWLAEPTMYCJQFN OXVKZRHGLDSUPAETF
YCBQMJJORWLHISZNKVUXDGFPAYNRTJHBLOZMCQWEYKSIPVFTRDGHXLANQZMBOJCUKWVTSREYQLIFDNZHAGXJBRCPTOVVWUMEQLYHKIZDXJSA
NGBROFTCQWUPLZVYMDNXIKJFEHSACROGVJWBQTM LUKYXZFPHVIDJEGONBARCTMSWLQZJYUKNFGXPODHVLEITCBQMSRXWUAZPLDN OFVKHEJ
IYBCTZGQKRAMS WFPXLJHYODUNEZVGTKICUBXQDLMPAWJFSONRHKTIZUVLBGYFCPXEQWJNLAKOSMDRTZFVUYHIXPBJCLGNQKWDZTEVSUXRAL
MHBOKNJCYPVITFWQZLEGMDSOXJC RYHANVBUKLFZPITGKWMCEXRQYDVSN OUBLPHJAKZFYGEXMMW TORVJLUINBSDCQKPHTROGLXFWMZVJYADE
BNQISCTKULHRWGYPZOMVFJBQLDNUEXRSWTHKZMAPYOLNUXVQFRJIGWCDESBHXTMQOKNPUJLZYGQFODVWSXARHCKMBILTJEPNZUYWGF XQO
VSLHPCRJIBTZMUADNEYOKL GWMFPXQRJBLAZDCTNHIIUYEKP SOGQMFWLBRXUYZINJDVOHTMKCSFPVAXYQZ NKGLWUEDHRJJOIMSVBCQTZFKPD
QAWYMXEJVGULOSBHNTRZKIYFPDCQNXTEVMJRWZHULGOAKSPBDIFJYCQLXVWNMEHTUZOSRKDGPHABFYJUKWQLZTCOEGIRNSHVPMDXAJBFRZ
LUWEQGTONYSIKXPCMWHODBFQXLGWEZTU AJPVSKRINYOHBMFQDRWGVUPTYZJAXOLNCHEKIJSVYQFTUBDMPGNHXR LWCOKAIZESJYZFMAVKPG
THRODQXSLNIBWEUVCYTQKDLFMZPXJHRGONBIAOSVKUYCHQD WLRJNFBPXETIMAGUZOJSKYL VPCRWHTXQDMNEFIULKGYBOJSKNPRAHCTVEFO
LQXZMWYUINDGBSRKJHAPTLX FONIWQBZDKURJEPVGMCMYHSBAQLNTIFXUQZVEJGKLDSYCNPHTRWBMMAVJZLKOQXIDGNURNMWPQJFTKSL OEHXBZ
VYDAGUMQRCNIXLPJTHFKSOVZWQCYBNGMRADJEPUXTISFVLOQKZNHCYMG BXPJHTDNARFVOQLUYKGWZEDXHSJIPABTVCMNOKW FYZQRLPHUIB
CTDNEVQWXAMSLKJPRYGBUZFHVOCNTJMXWEKIALYSRPHOQFVGNBTJZMKDXULVCEQIAZPYHTNFUJWMLRBGQXSVDP EOIHKYCZFWOLJRBADPUV
GNXIMKSYQHTWZJFCEQKV OBRDGPUTCNCWXIHLAYSVMJEFQLOKNBP RDXITJWUAQSYVOBLZEGCUMHKPNWTRFXIDQYEJSNOBLGPKWAI RZCUHTF
VXDJNMGLEPSOYQKHIZBWAVLPTUMSRGJNXECFYQDKVJWBHTIFGZOWUPM CYLDTBQKSARXJVHZFWLPIONMGUCYRXDSJETFBQNKAVPULRHWZMI
COGSJXLKQNFUBYVTAPEMIZORCGXWTJHLQDV KSNYBUAFWPZJONQCIYMKRSHVLGBDXTUPJOAHFYWVKNRMEZSGBDQLPUCJITRXOKYWANVL TZP
FGQJLEYQUPTKDJCVRNHSMZFI GLWODQBPEYURKNVXTJMCZAFHOEBLWPIGRUQXDYNSMVKTJHRCAFWPELGIYQXUZDOKMTBNR VJSCHQLPXFY
IZKOGMTJADNUSVBR LHPQCYOZNEFKGTMXWDJHRIPULSBVACOLN YEQKJTGZWUDXMPHBRKIQYSJNEVAFZLCGWBDPOTNHMXYRFXUJLVZEOCXQI
NAGTHBDPRMWSJKFYUOLVICZQAXNRGHPMJOTKLUESBYVDWCFNQY ZAKURMTHJVEGBXIPOLWCQSNURDYXLTKVAGJMF BZIPHOCDWREXLMYQSN
UJTVKAFGODIYBZLHCPWRXMXN QESKVJFBGT OULPHZARYIDNMWCVJTGQKEPSYRLZBNHXOCWMUVTPQPKADGJSIEZRYNBFXLHWOTMVRKPUGJDCZI
YBQWAHSOLXFUMEVYCTNBGJZRKDPLIQWHAONVSYXUCJZBIFGRDKMLTPQEYSHOWAUVN XFMLJKZITCRGSPVYBQDOHWRLXJEMTKCFNPAUZQYD
GHVSINOLMRXBTJYWUEZKIVNPLSFMDYBQGH TARUOJXCZFWKLEPNVTXSYAIH ZMBGRQDKJULFONCPVXWHIEOTYRSJBUZGAXLFMKQWYIRPNDZVE
JHCOSTBDUXNMLPZGJKRIQVAHFYEW SCLNBTOJXZUKMPVWDLG SNCQORYEFZHJLUAKXVMPCTNSQJDY GWR LBAIFKXPHMU VONZDJLWTVISUCQ GK
YRAZPHEBOMXLNWQDJKFTCPGSUIRVXMEZYOQBT LNHJCWDAZRVUKGOFIPXMNEYWSHJQDBLTFACKPVZOMSLURGYNIHXQWJTCVEDOKAFYLSN
MPHGZURWJOIECKTYFLPXVAMRDQNHGKSIWOBLUZVYTCQFDJPMHRXENGISOLBZWKAUTVPRQY LNXMFDJCBIKZGSROWHTPEUYQAVCMXRWFLSN
DHPGZTJQIBUKYOEXVMFWZJ DALHCURPNTIGQKSYXOBELNWF AHJZRVRQGMTKSYDIPCEUKBJLONHRFYAVTGXUQPSNMZIWRFD OVYEKBQJHMMWPLG
SYTZFANURIOXVCJLWKHPQMGZTEFDNBISVOYXQTCJAULRZGMPBFKHNDVWYSIECLJOQAKTUPHXGZRVBOBYMWLFJDPQIXTUSCHENRLWFKOMGAJ
DHZBIQPTYVYXKSMCBURLFGONJXTUQAZMSPYCJHRLKTWXVIQDHGOBYFNLJZVERMWPAKSUNCXTFHDQBILGORPKYWAMNVELT XCSUJDBRZPHF
GMOQWAKVIJNEXYDUPDLZRTBQHMSCLFKZNVYXTAJWOGQEDBPUMRLHYCJIWNFTOKXVQGS DYARMZCBEPHUIWLTXDJKOVAGR FYNQCSPHXOTMZL
RKEJYVDUWGANI BTCLZPSXHQRMUJOKGQDAWNVYXBHDCYEUSMXLIWOTFVRNZPTXJCQGSOMDVHAKRLFUBIQEPZWYXTVKGMOSZLUHNACBDIP
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QUCNVGIXDBTFOSMRHJYKLPZDAGBWQXIJCUNKLTLEFPYVZH XGRMDIOWTQJNFCBUKSZRQAVMPLIWGDYETOKHFXBJUCPQVTLRLINYGWAVOMSKZE
BLHQDFYJNPXUTCEIZKH BGSQLV DWRYPJNFCUOXTAGKHL YVIJEZRQNSCWPMDFOGTGBX EKURLNHTPAJWSQMODVIZXURGHJYFCNBQKPWTEAVLM
RSDIZOKBGQWJTXYCNPDLHUREAVGFOMSKJBQBXWZNL YITPCFHDXXX

CODE:

```
#!/usr/bin/env python3
```

```
import time
```

```
import pickle
```

```
import numpy as np
```

```
import matplotlib.pyplot as plt
```

```
def save_key_to_file(file_path, key):
```

```
    with open(file_path, 'wb') as f:
```

```
        pickle.dump(key, f)
```

```
def load_key_from_file(file_path):
```

```
    try:
```

```
        with open(file_path, 'rb') as f:
```

```
            return pickle.load(f)
```

```
    except FileNotFoundError:
```

```
        print(f"Key file {file_path} not found. Ensure the key exists.")
```

```
    return None
```

```
def caesar_cipher(text, shift, encrypt=True):
```

```
    shift = shift if encrypt else -shift
```

```
    result = ""
```

```
    for char in text:
```

```
        if char.isalpha():
```

```

        shift_base = 65 if char.isupper() else 97

        result += chr((ord(char) - shift_base + shift) % 26 + shift_base)

    else:

        result += char

    return result

```

```

def generate_key_matrix(keyword):

    matrix = []

    seen = set()

    for char in keyword.upper() + "ABCDEFGHIJKLMNOPQRSTUVWXYZ":

        if char not in seen and char != 'J':

            seen.add(char)

            matrix.append(char)

    return [matrix[i:i + 5] for i in range(0, 25, 5)]

```

```

def find_position(char, matrix):

    for i, row in enumerate(matrix):

        if char in row:

            return i, row.index(char)

    raise ValueError(f"Character {char} not found in matrix")

```

```

def playfair_cipher(text, key, encrypt=True):

    matrix = generate_key_matrix(key)

    text = ".join([char for char in text.upper() if char.isalpha()])

    text = text.replace("J", "I")

    processed_text = []

    i = 0

```

```

while i < len(text):

    if i == len(text) - 1 or text[i] == text[i + 1]:

        processed_text.append(text[i] + 'X')

        i += 1

    else:

        processed_text.append(text[i:i + 2])

        i += 2

result = ""

for pair in processed_text:

    a, b = pair[0], pair[1]

    row1, col1 = find_position(a, matrix)

    row2, col2 = find_position(b, matrix)

    if row1 == row2:

        col1 = (col1 + (1 if encrypt else -1)) % 5

        col2 = (col2 + (1 if encrypt else -1)) % 5

    elif col1 == col2:

        row1 = (row1 + (1 if encrypt else -1)) % 5

        row2 = (row2 + (1 if encrypt else -1)) % 5

    else:

        col1, col2 = col2, col1

    result += matrix[row1][col1] + matrix[row2][col2]

return result

```

```

def mod_inverse(matrix, modulus):

    det = int(round(np.linalg.det(matrix)))

    if det % modulus == 0 or np.gcd(det % modulus, modulus) != 1:

        raise ValueError("Key matrix is not invertible modulo 26.")

    det_inv = pow(det % modulus, -1, modulus)

    adjugate = np.round(det * np.linalg.inv(matrix)).astype(int) % modulus

    matrix_inv = (det_inv * adjugate) % modulus

```

```
return matrix_inv
```

```
def hill_cipher(text, key, encrypt=True):
```

```
    n = int(np.sqrt(len(key)))
```

```
    matrix_key = np.array(key).reshape(n, n) % 26
```

```
    if not encrypt:
```

```
        matrix_key = mod_inverse(matrix_key, 26)
```

```
    text = text.upper().replace(" ", "")
```

```
    if len(text) % n != 0:
```

```
        text += "X" * (n - len(text) % n)
```

```
    result = ""
```

```
    for i in range(0, len(text), n):
```

```
        vector = np.array([ord(char) - 65 for char in text[i:i + n]])
```

```
        transformed = np.dot(matrix_key, vector) % 26
```

```
        result += ".join(chr(int(num) + 65) for num in transformed)
```

```
    return result
```

```
def read_file(file_path):
```

```
    try:
```

```
        with open(file_path, 'r') as file:
```

```
            return file.read()
```

```
    except FileNotFoundError:
```

```
        return ""
```

```
def write_to_file(file_path, text):
```

```
    try:
```

```
        with open(file_path, 'w') as file:
```

```
        file.write(text)

except IOError:

    pass
```

```
def measure_time(cipher_func, text, *args):
```

```
    start_time = time.time()
```

```
    cipher_func(text, *args)
```

```
    return time.time() - start_time
```

```
def run_timing_tests(file_path):
```

```
    input_text = read_file(file_path)
```

```
    if not input_text:
```

```
        print("No text to process. Exiting test.")
```

```
        return None
```

```
    shift = load_key_from_file('caesar_key.bin')
```

```
    playfair_key = load_key_from_file('playfair_key.bin')
```

```
    hill_key = load_key_from_file('hill_key.bin')
```

```
    caesar_encrypt_time = measure_time(caesar_cipher, input_text, shift, True)
```

```
    caesar_decrypt_time = measure_time(caesar_cipher, input_text, shift, False)
```

```
    playfair_encrypt_time = measure_time(playfair_cipher, input_text,
                                         playfair_key, True)
```

```
    playfair_decrypt_time = measure_time(playfair_cipher, input_text,
                                         playfair_key, False)
```

```
    hill_encrypt_time = measure_time(hill_cipher, input_text, hill_key, True)
```

```
    hill_decrypt_time = measure_time(hill_cipher, input_text, hill_key, False)
```

```
    text_length = len(input_text)
```

```
encryption_times = [caesar_encrypt_time, playfair_encrypt_time,  
                    hill_encrypt_time]
```

```
decryption_times = [caesar_decrypt_time, playfair_decrypt_time,  
                   hill_decrypt_time]
```

```
return encryption_times, decryption_times, text_length
```

```
def plot_graph(encryption_times, decryption_times, text_length):
```

```
    bar_width = 0.35
```

```
    index = np.arange(len(encryption_times))
```

```
    fig, ax = plt.subplots(figsize=(10, 6))
```

```
    bar1 = ax.bar(index, encryption_times, bar_width,
```

```
                  label='Encryption Time', color='blue')
```

```
    bar2 = ax.bar(index + bar_width, decryption_times, bar_width,
```

```
                  label='Decryption Time', color='green')
```

```
    ax.set_xlabel('Cipher Type')
```

```
    ax.set_ylabel('Time (seconds)')
```

```
    ax.set_title(f'Encryption and Decryption Times for {text_length} characters')
```

```
    ax.set_xticks(index + bar_width / 2)
```

```
    ax.set_xticklabels(['Caesar', 'Playfair', 'Hill'])
```

```
    ax.legend()
```

```
    plt.tight_layout()
```

```
    plt.show()
```



```

def menu():

    while True:

        print("\nChoose an action:")

        print("1. Encrypt and Save All Ciphers (Caesar, Playfair, Hill) to Files")

        print("2. Decrypt and Save All Ciphers (Caesar, Playfair, Hill) from Files")

        print("3. Test Encryption/Decryption Time for a File")

        print("4. Plot Encryption/Decryption Times")

        print("5. Exit")

        choice = input("Enter choice (1-5): ")

    try:

        if choice == '1':

            input_text = read_file('text.txt')

            caesar_encrypted = caesar_cipher(input_text, 3, encrypt=True)

            playfair_encrypted = playfair_cipher(input_text, "WHICH", encrypt=True)

            hill_encrypted = hill_cipher(input_text, [11, 2, 19, 5, 23, 25, 20, 7, 17], encrypt=True)

            write_to_file('caesar_encrypted.txt', caesar_encrypted)

            write_to_file('playfair_encrypted.txt', playfair_encrypted)

            write_to_file('hill_encrypted.txt', hill_encrypted)

            save_key_to_file('caesar_key.bin', 3)

            save_key_to_file('playfair_key.bin', "WHICH")

            save_key_to_file('hill_key.bin', [11, 2, 19, 5, 23, 25, 20, 7, 17])

        elif choice == '2':

            caesar_encrypted = read_file('caesar_encrypted.txt')

            playfair_encrypted = read_file('playfair_encrypted.txt')

            hill_encrypted = read_file('hill_encrypted.txt')

            caesar_decrypted = caesar_cipher(caesar_encrypted, load_key_from_file('caesar_key.bin'), encrypt=False)

```

```
playfair_decrypted = playfair_cipher(playfair_encrypted, load_key_from_file('playfair_key.bin'), encrypt=False)

hill_decrypted = hill_cipher(hill_encrypted, load_key_from_file('hill_key.bin'), encrypt=False)


write_to_file('caesar_decrypted.txt', caesar_decrypted)

write_to_file('playfair_decrypted.txt', playfair_decrypted)

write_to_file('hill_decrypted.txt', hill_decrypted)


elif choice == '3':

    file_path = './text.txt'

    times = run_timing_tests(file_path)

    if times:

        encryption_times, decryption_times, text_length = times

        print(f"Encryption Times: {encryption_times}")

        print(f"Decryption Times: {decryption_times}")


elif choice == '4':

    file_path = './text.txt'

    times = run_timing_tests(file_path)

    if times:

        encryption_times, decryption_times, text_length = times

        plot_graph(encryption_times, decryption_times, text_length)


elif choice == '5':

    break


except ValueError:

    pass


menu()
```