More Fun with Ciphers!

October 8th, 2015

Encoding with the Rail Fence Cipher

1. Encode the phrase WE NEED YOUR HELP using the Rail Fence cipher.

   (a) First, make an outline of the zig-zag pattern for the number of letters that are in your message.

   (WE NEED YOUR HELP has 14 letters.)

__				__				__				__	
	__		__		__		__		__		__		__
		__				__				__			

   i. Arrange the letters of the message on the zig-zag pattern:

W				E				U				L	
	E		E		D		O		R		E		P
		N				Y				H			

   ii. Then, the encoded phrase is written out left-to-right, top-to-bottom. This time, we have also divided the message into three "words" (each word has letters written on one of the lines above) .

   WEUL EEDOREP NYH

   (b) Use the Rail Fence cipher to encode the message

   I WILL BE THERE SOON

__				__				__				__			
	__		__		__		__		__		__		__		__
		__				__				__				__	

   What will the encoded text read?

Decoding Rail Fence Cipher

1. Decode the following message:

   BRRT EAEFOOS WOB

   Since the message is divided into 3 “words” (corresponding to the first, second and third row), you can simply read off the message as follows:

   (a) Write down the *first* letters of each of the three words (first, second, third):

   B E W

   (b) Then, write down the *second* letters of each of the three words (second, first, third) (watch out for the order of the words!!!):

   B E W

   ...

   (c) Continue writing the next letters going back and forth from 1st word, to 2nd, to 3rd, to 2nd, to 1st, to 2nd, to 3rd, etc.
   Finish decode the message above using this method (it was encoded using the Rail Fence cipher):

2. Try to decode the following message:

   IEHTLVMTEAISOAMC

   First, count the number of letters in the message. The message has 16 letters. Draw a zig-zag pattern with spaces for 16 letters, like this:

__				__				__				__			
	__		__		__		__		__		__		__		__
		__				__				__				__	

   Fill in the spaces, starting with the first row, continuing with the second, etc. Double check that when you read the table row by row, it says IEHT LVMTEAIS OAMC. Now read and record the message by following the zig-zag pattern:

3. As we have seen, if the message is *not* divided into three “words”, decoding gets more complicated. Here is what you need to do:

(a) Count the number of letters in the message. In the message above, the number of letters is ____.

(b) Make an outline of the zig-zag pattern like we did above for the number of letters in the message:

(c) Fill in the top row first (fill in letters into the boxes with underlined spots only)

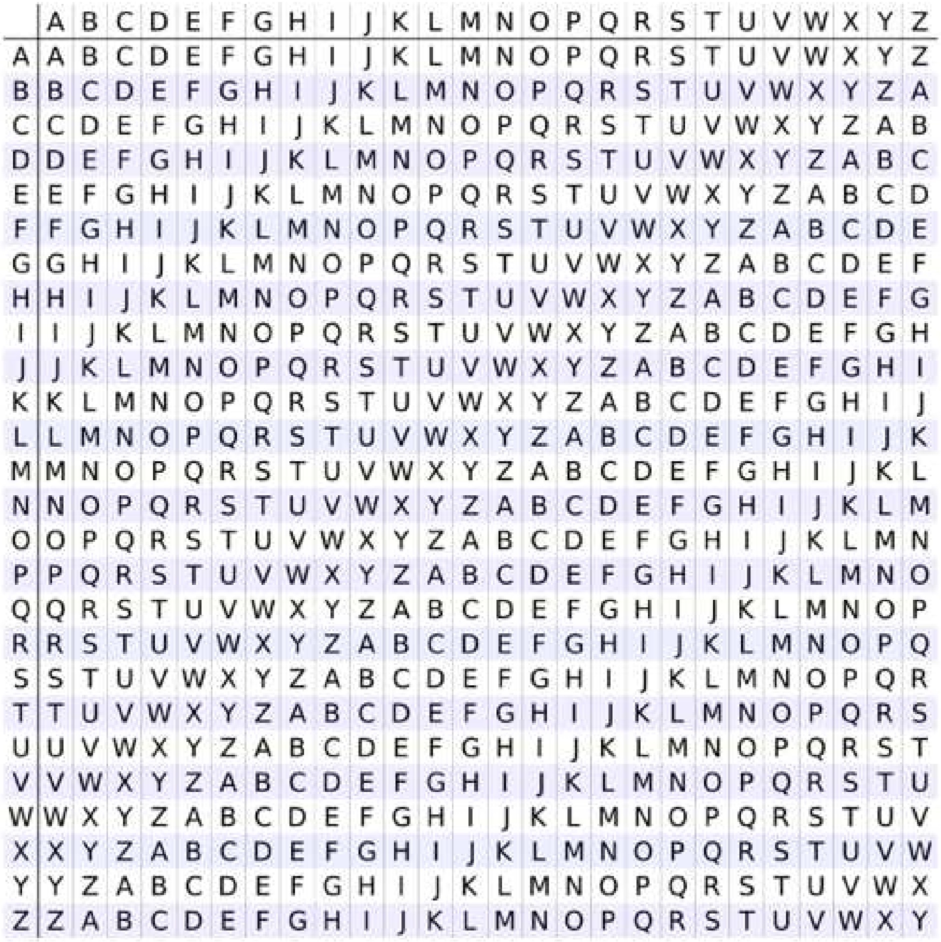
(d) After that fill in the middle row

(e) Finally, fill in the third row

(f) Write down the message (going along the zig-zag pattern), inserting spaces where necessary:

Vigenère Cipher

Below is a Vigenère Cipher:



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
A	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
B	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A
C	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B
D	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C
E	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D
F	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E
G	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F
H	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G
I	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H
J	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I
K	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J
L	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K
M	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L
N	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M
O	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N
P	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
Q	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
R	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
S	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
T	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
U	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
V	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
W	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
X	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W
Y	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X
Z	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y

1. Let's figure out how this table is constructed:

   (a) Take a look at the row labeled **A**. How is it related to the alphabet?

   (b) How is row **C** obtained from the alphabet?

   (c) How is row **Z** obtained from the alphabet?

   (d) What can you say about all of the rows? Explain how this table is made. Once you are done with that, you are ready to use the Vigenère to encode messages!

2. Here is how encoding with the Vigenère cipher works:

(a) First, choose a *keyword*. The keyword should be known to the encoder and the reciever of the message. It is kept secret from everyone else. For example, we will use the keyword CAR. *The keyword tells you which rows to use in the encoding.*

(b) Then, select the message you want to send. For example, the message can say UNDERATTACK

(c) Repeat the keyword enough times to get the length of the message. For example, UNDERATTACK is a message consisting of 13 letters. The repeated keyword will look as follows:

UNDERATTACK
CARCARCARCA

(d) Finally, we are ready to encode. In this example, we will only use three rows (**C**, **A** and **R**).
To encode, write down the repeated keyword under the message:

message:	**U**	**N**	**D**	**E**	**R**	**A**	**T**	**T**	**A**	**C**	**K**
repeated keyword:	C	A	R	C	A	R	C	A	R	C	A
encoded message:	**W**	**N**									

For each letters in the message, the letter in the repeated keyword tells you which word you need to use for encoding.
For example, to encode the first letter of the message (**U**), use row **C**. The encoded letter will be W.
In the same way, to encode the second letter of the message (**N**), use row **A**. The encoded letter will be A.

(e) Continue in the same way. First, find Row **C**, then we identify Column **U**. The first encoded letter is W because this is where these two cross. Next we look for Row **A** and Column **N** to get the next encoded letter, N.

Encode the rest of the message into the table above.

(f) Knowing that the keyword is CAR, decode the following message:

IOFFJFDTYCTNCSYCRU

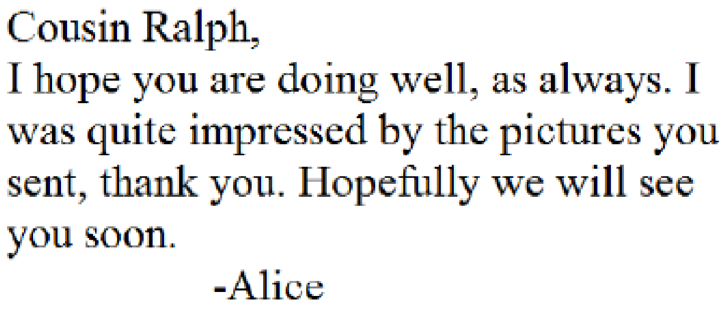
Use the table below to help you organize your thoughts:

message																		
repeated key word	C	A	R															
encoded message	**I**	**O**	**F**	**F**	**J**	**F**	**D**	**T**	**Y**	**C**	**T**	**N**	**C**	**S**	**Y**	**C**	**R**	**F**

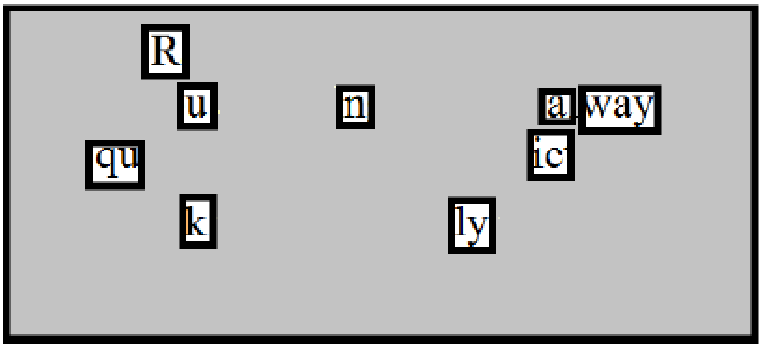
Cardan Grille

In this method of encoding, a message is hidden within a larger text, and the key to decoding it is a grid with cutouts that reveal the letters of the actual message.

1. Below is a message that appears to be a letter from someone named Alice to her Cousin Ralph. After looking at it using the attached grid, it reveals a hidden message.

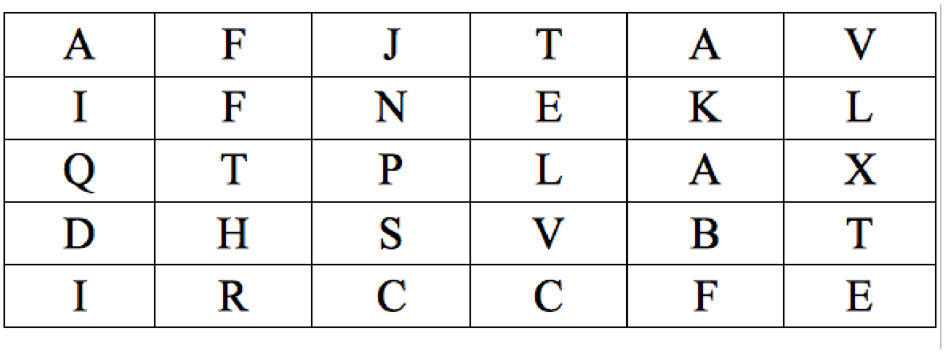


Cousin Ralph,
I hope you are doing well, as always. I
was quite impressed by the pictures you
sent, thank you. Hopefully we will see
you soon.
-Alice



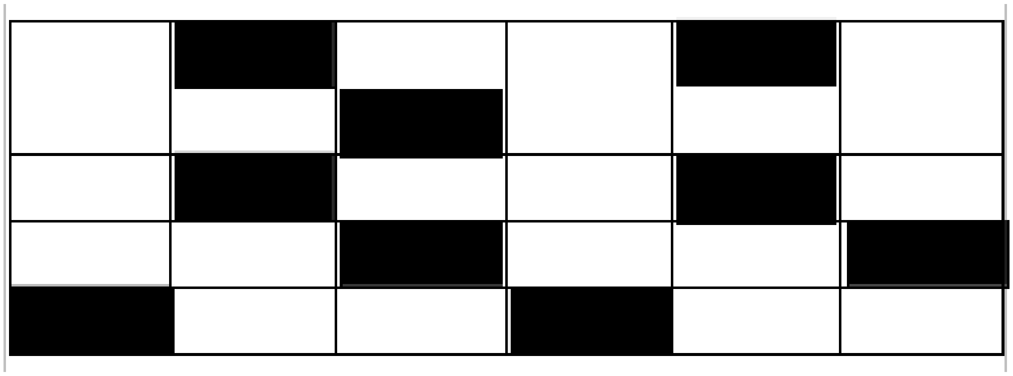
What is the letter really telling the reader?

2. Sometimes the message is hidden within other words. Use the grille on the next page to decode the message hidden in the words below. (Black rectangles on the grille on the next page denote the places that would have been cut out).



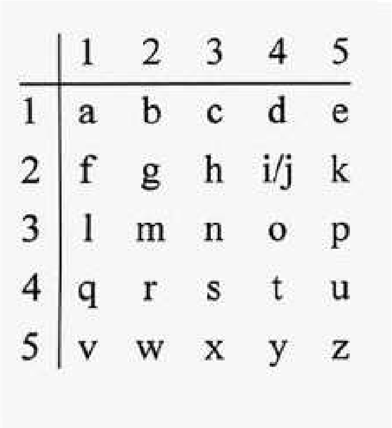
A	F	J	T	A	V
I	F	N	E	K	L
Q	T	P	L	A	X
D	H	S	V	B	T
I	R	C	C	F	E

(a) Notice that the surrounding letters do not need to be really meaningful. Now try making your own message for your partner with the grille you made.



Greek Square Cipher

1. A famous historian and cryptographer, named Polybius, invented the Greek Square Cipher 2,200 years ago:



	1	2	3	4	5
1	a	b	c	d	e
2	f	g	h	i/j	k
3	l	m	n	o	p
4	q	r	s	t	u
5	v	w	x	y	z

(a) Each letter in the alphabet is replaced by a two digit number corresponding to its position in the square matrix. The *Row Number* is in front of the *Column Number*. For example,

- the letter M is encoded by 32;
  - the word MATRIX is encoded by 321144422453;

i. Find the two digit numbers that correspond to the following letters:

$$n =$$
$$r =$$
$$i =$$
$$j =$$

ii. Do you think it is a problem that both i and j are encoded by the same number? Explain.

iii. Decipher the following message
24 11 32 42 45 33 33 24 33 22 34 45 44 34 21 32 15 43 43 11 22 15 43