Vigenere Cipher

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Polyalphabetic Ciphers

The relationship between a character in the plaintext to a character in the cipher text is one-to-many.

Vigenere Cipher

- The Vigenere cipher is the kind of polyalphabetic cipher.
- It was design by Blaise de Vigenere, a 16th century French mathematician.
- It was used in the American civil war and was once believed to be unbreakable.
- A Vigenere cipher uses a different strategy to create the key stream. The key stream is a repetition of an initial secret key stream of length m, where we have 1<=m<=26.
- The Vigenere cipher is a method of encrypting alphabetic text by using a series of different Caesar ciphers based on the letters of a keyword.
- The Vigenere cipher uses multiple mixed alphabets, each is a shift cipher.

Vigenere Cipher

Plain text:

$$P = P_1 P_2 P_3 \ldots$$

Cipher text:

$$C = C_1 C_2 C_3 \ldots$$

Key stream:

$$K = [(k_1, k_2, \ldots, k_m), (k_1, k_2, \ldots, k_m), \ldots]$$

Encryption:

$$C_i = P_i + k_i$$

Decryption:

$$P_i = C_i - k_i$$

Example

- We can encrypt the message **"She is listening"** using the 6-character keyword **"PASCAL"**. The initial key stream is **(15,0,18,2,0,11).** The key stream is the repetition of this initial key stream (as many times as needed) .

Use encryption algo:

$$C_i = P_i + k_i$$

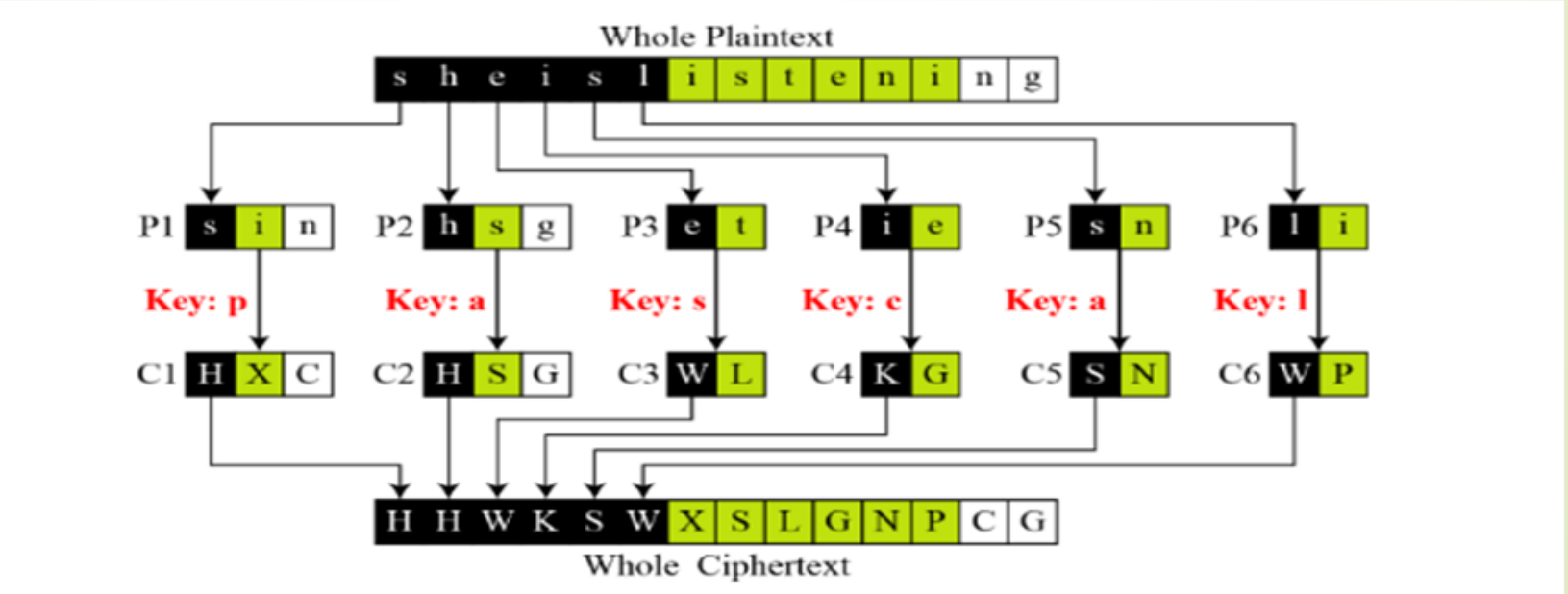
Plaintext:	s	h	e	i	s	l	i	s	t	e	n	i	n	g
P's values:	18	07	04	08	18	11	08	18	19	04	13	08	13	06
Key stream:	***15***	***00***	***18***	***02***	***00***	***11***	***15***	***00***	***18***	***02***	***00***	***11***	***15***	***00***
C's values:	**07**	**07**	**22**	**10**	**18**	**22**	**23**	**18**	**11**	**6**	**13**	**19**	**02**	**06**
Ciphertext:	**H**	**H**	**W**	**K**	**S**	**W**	**X**	**S**	**L**	**G**	**N**	**T**	**C**	**G**

Note:-

- The Vigenere key stream dose not depend on the plaintext characters. It depends only on the position of the character in the plain text.

Example cont....

- Vigenere cipher can be seen as combinations of m additive ciphers.



Vigenere Table

- Another way to look at Vigenere ciphers is through what is called a Vigenere Tableau, Vigenere Table or Vigenere Square.
- The first row of this table has the 26 English letters. Shows the plain text character to be encrypted.
- Starting with the second row, each row has the letters shifted to the left one position in a cyclic way. For example, when **B** is shifted to the first position on the second row, the letter **A** moves to the end.
- The first column contains the characters to be used by the key.

	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

Example:-

- To find the cipher text for the plaintext **"she is listening "** using the word **"PASCAL"** as the key
  - .we can find **"s"** in the first row, **"p"** in the first column, the cross section is the cross section is the cipher text character **"H"**
  - we can find **"h"** in the first row, **"A"** in the first column, the cross section is the cross section is the cipher text character **"H"**
  - And so on…..

Encrypt example:

"TO BE OR NOT TO BE THAT IS THE QUESTION"

Use Vigenere table method to encrypt plain text to cipher text.

Plaintext: TOBEO RNOTT OBETH ATIST HEQUE STION

Keyword: RELAT IONSR ELATI ONSRE LATIO NSREL

Ciphertext: KSMEH ZBBLK SMEMP OGAJX SEJCS FLZSY

Decrypt example:

"TO BE OR NOT TO BE THAT IS THE QUESTION"

Use Vigenere table method to decrypt cipher text to plain text.

Keyword: RELAT IONSR ELATI ONSRE LATIO NSREL

Ciphertext: KSMEH ZBBLK SMEMP OGAJX SEJCS FLZSY

Plaintext: TOBEO RNOTT OBETH ATIST HEQUE STION

Exercise-1

Plain text: MICHIGAN TECHNOLOGICAL UNIVERSITY

Keyword: HOUGHTON

Cipher text: TWWNPZOA ASWNUHZBNWWGS NBVCSLYPMM

Vigenere Cipher (Crypanalysis)

- This method was actually discovered earlier, in 1854 by Charles Babbage.
- Vigenere-like substitution ciphers were regarded by many as practically unbreakable for 300 years.
- In 1863, a Prussian major named **Kasiski** proposed a method for breaking a Vigenere cipher that consisted of finding the length of the keyword and then dividing the message into that many simple substitution cryptograms.


THANK YOU
ANY QUESTIONS?