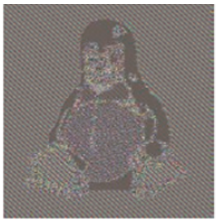
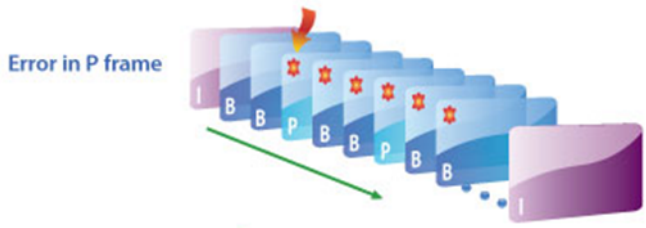
Assignment 5

Task 1: Lab on Testing Different Modes in Symmetric Ciphers





Symmetric key cryptography provides several modes of operation, including Electronic Codebook (ECB), Cipher-Block Chaining (CBC), Cipher Feedback (CFB), Output Feedback (OFB), and Counter Mode (CTR), as shown in Figure 1. Modes of operation have been devised to encipher text of any size employing either DES or AES. Two important properties of these encryption modes that this lab will explore are **pattern preservation** and **error propagation**. Pattern preservation means that a block of plaintext is encrypted into a block of cipher text the same way every time; e.g. if Eve finds out that cipher text blocks 1, 5, and 10 are the same, she knows that plaintext blocks 1, 5, and 10 are the same. Error propagation means that a single bit error in transmission of a cipher text block creates errors in not only the decryption of the affected block, but propagates to the following blocks of the message.

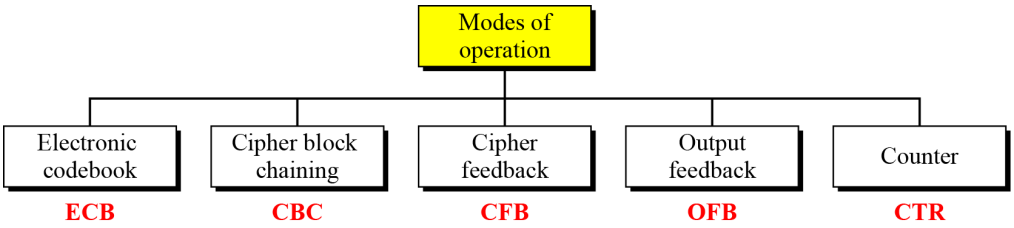


Figure 1. Modes of Operation

Lab Tasks

Create an application to encrypt and decrypt messages using DES or AES ciphers using a programming language/cryptographic package of your own choice. Java has a mature offering in the form of its Java Cryptography Extension, which is integrated with the Java 2 SE SDK. An article on using AES with Java can be found here:

http://java.sun.com/developer/technicalArticles/Security/AES/AES_v1.html. BSAFE from RSA is available under share project. You can choose a language/package that allows for the selection of operation mode (ECB, CBC, etc.) for encryption/decryption.

Task 1 Implement DES and AES ciphers. (50 points)

Create an application in the language of your choice that implements encryption of a plaintext series of bytes, and decryption of the created cipher text.

Task 2 Investigate Properties of Modes in DES and AES (50 points)

Your application should use either AES or DES encryption, and employ each of the following algorithm modes: ECB, CBC, CFB, OFB, and CTR. Your application should test pattern preservation by encrypting plaintext that includes a pattern, and examining the cipher text to see if the pattern is preserved. Your program should test error propagation by modifying one byte of the cipher text prior to decryption, and then examining the decrypted plaintext. The output from your program should resemble the following:

opmode: CFB

input : 00 01 02 03 04 05 06 07 08 09 0a 0b 0c 0d 0e 0f 00 01 02 03 04 05 06 07

cipher: 61 a1 f8 86 ff 9b c7 09 4f c0 bc 1b 17 3a d7 bb c7 d7 1a 36 61 45 dd a8

Modifying random byte: bb->ba

plain : 00 01 02 03 04 05 06 07 08 09 0a 0b 0c 0d 0e 0e 34 8b 0c bf fb 7f 9c de

Prepare a written report of your examination of the two discussed properties of the different cryptographic modes of operation. Include a completed version of the table below in your report (fill in each block with a yes, no, or other comment). Include the source code of your application with your report.

	ECB	CBC	CFB	OFB	CTR
Pattern preservation					
Error propagation					

Hint:

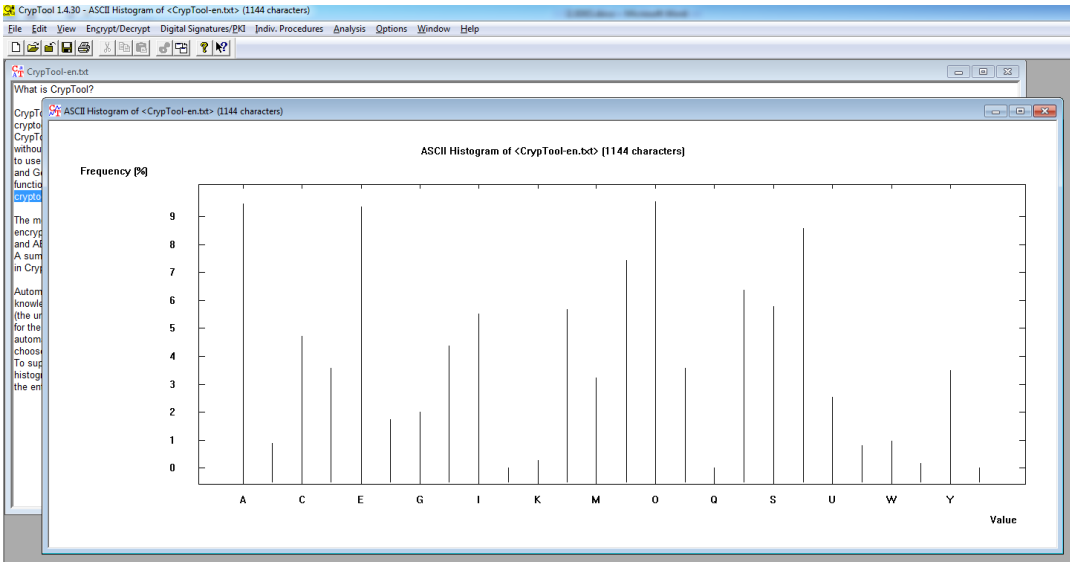
To test pattern preservation property, you can include repeated blocks in your plaintext and observe the results of cipher text.

To test error propagation property, you can encrypt plaintext first and then modify one bit in ciphertext and check the decryption results.

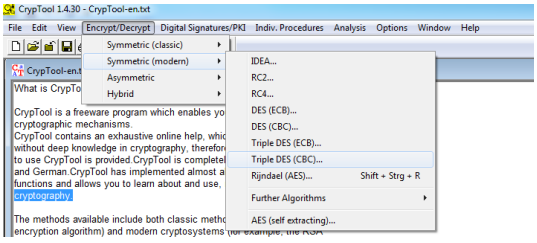
Taks 3: Triple DES with CBC mode and Weak DES keys (practice)

1. Open file "**CrypTool-en.txt**" from "**C:\Program Files (x86)\CrypTool\examples**".

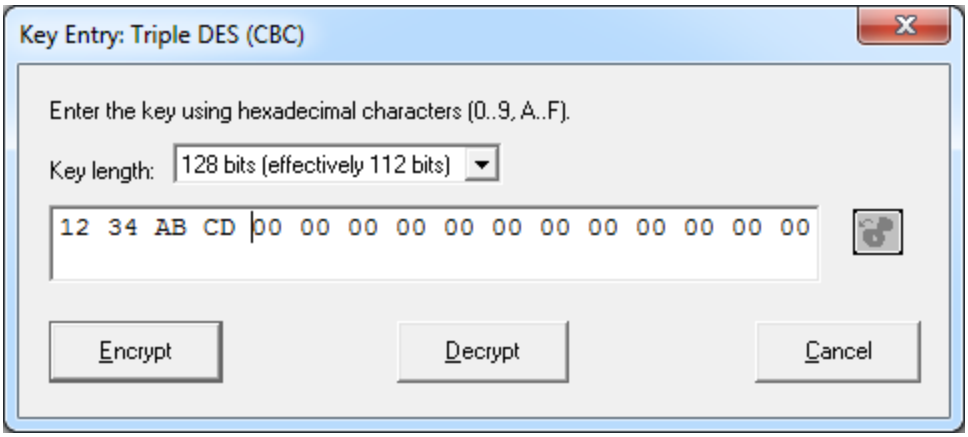
2. Look at the frequency distribution of the characters by clicking "**Analysis\Tools for Analysis \ Histogram**".



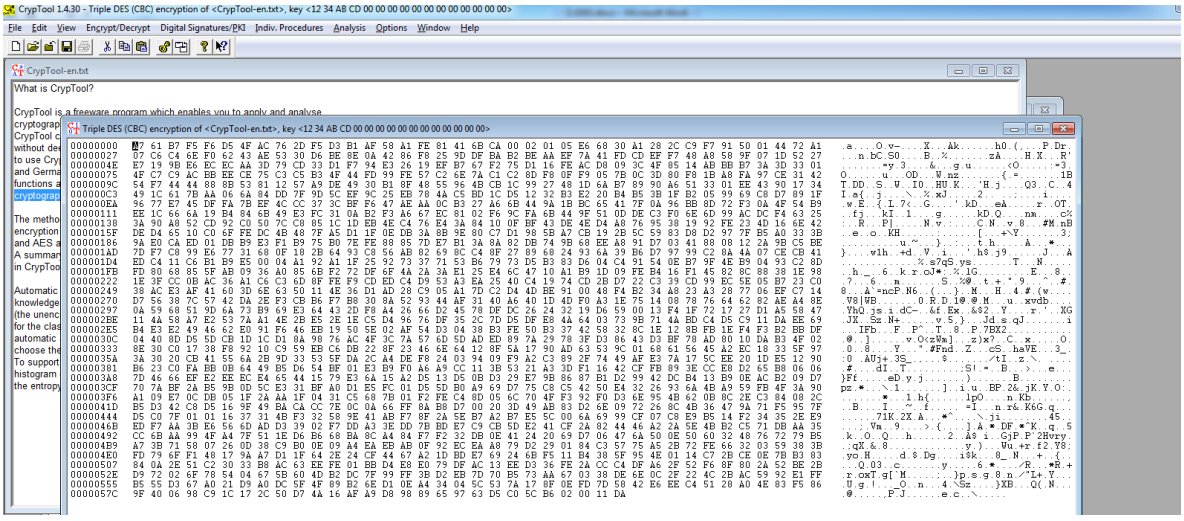
3. Encrypt the document by selecting "**Encrypt/Decrpt\Symmetric (modern)\Triple DES (CBC)**".



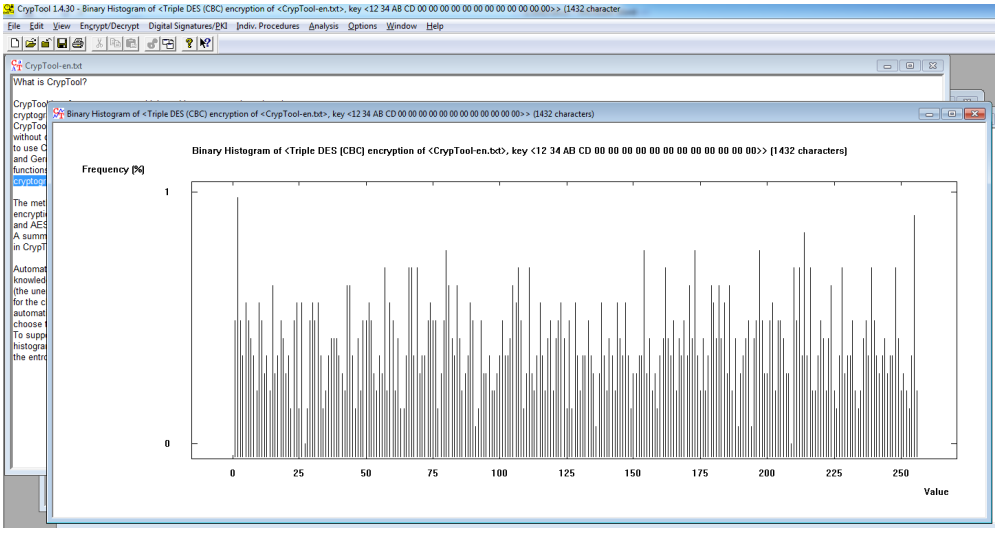
4. Use **12 34 AB CD** as the key.



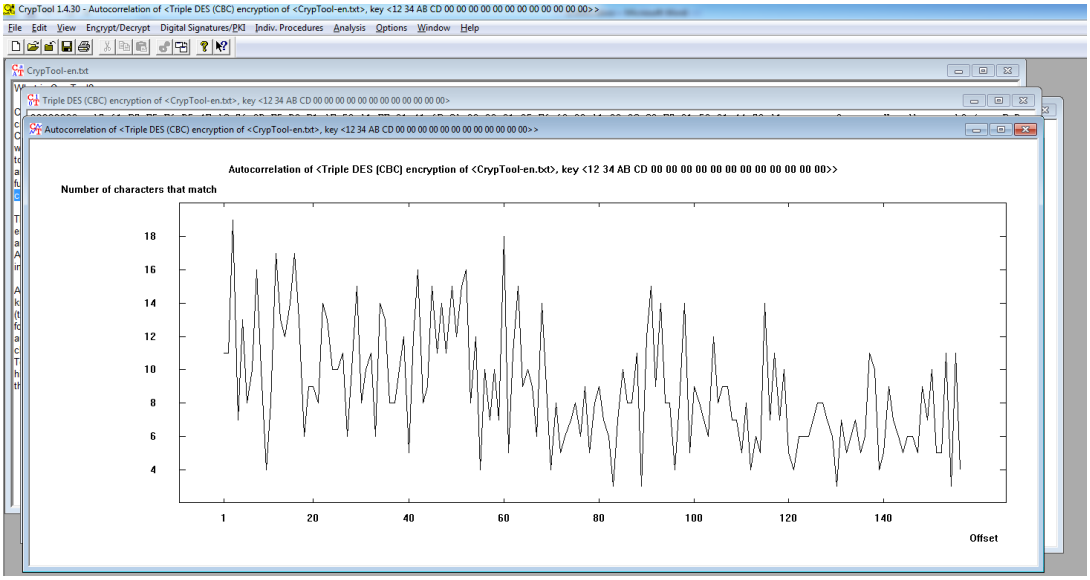
5. Click the **Encrypt** button.



6. Look at histogram of the encrypted document, which bears no resemblance to the histogram of the unencrypted document.



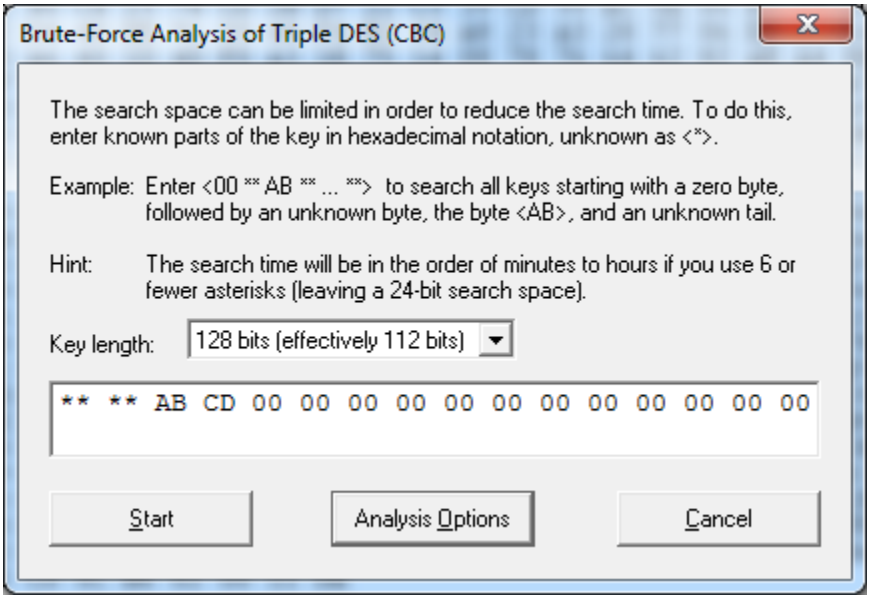
7. The autocorrelation exhibits no regularity which may provide a clue as to the key length.



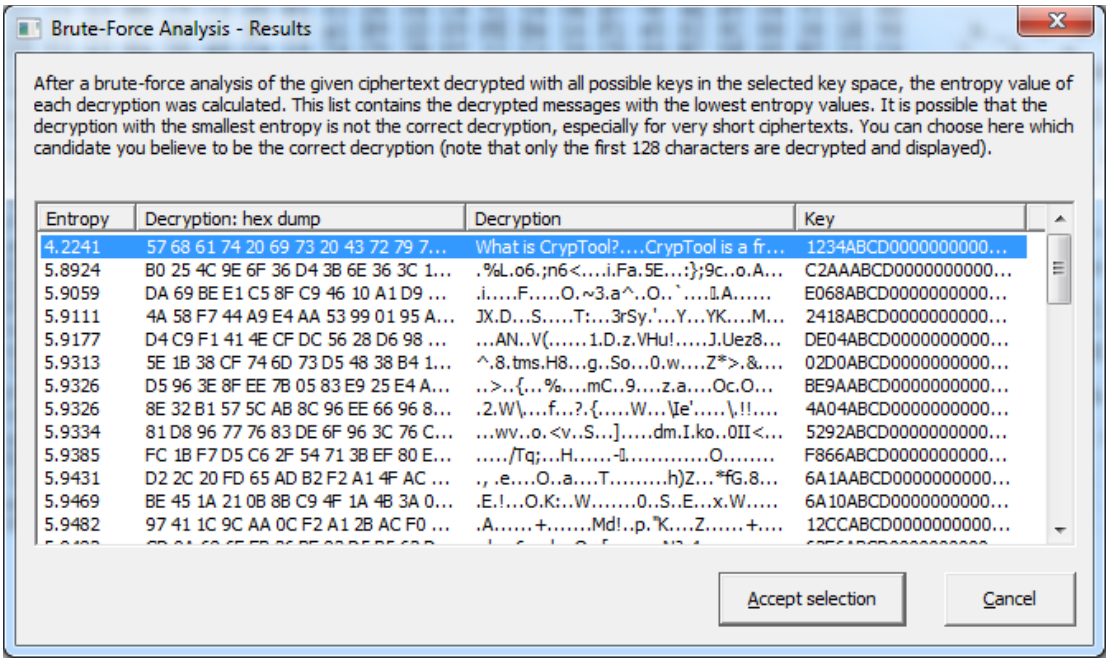
8. The decryption of the document functions like encryption except that the Decrypt button is clicked.

9. We want to determine the key from the encrypted document using a brute-force attack.

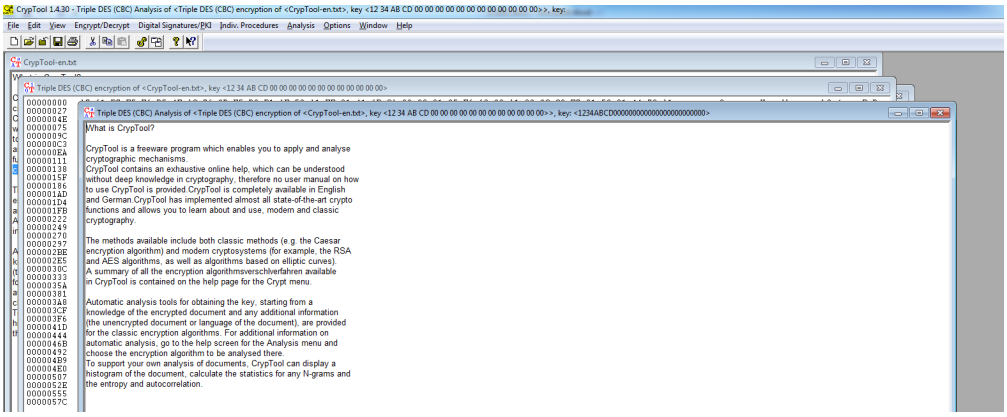
Select "**Analysis\Symmetric Encryption (modern)\Triple DES (CBC)**" from menu. Enter **** **** AB CD 00 00 00 00 00 00 00 00 00 00 00 00 00 00** as the key.



10. Click "**Start**".

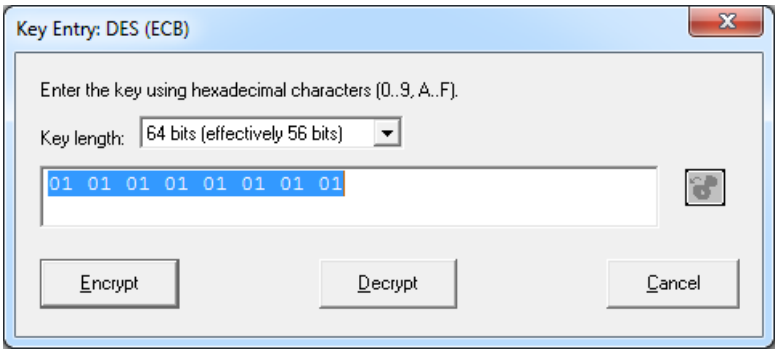


11. The first one returns readable results. Click "**Accept selection**". The original plaintext shows up.

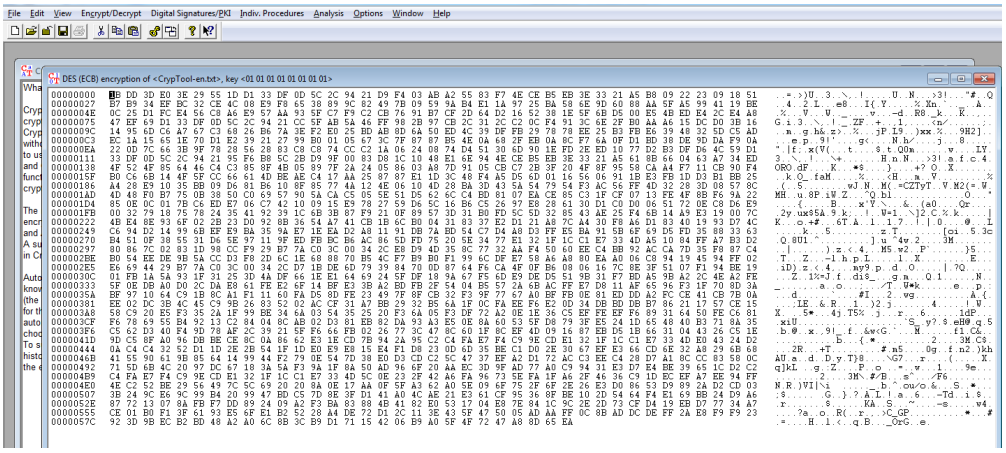


Weak DES Keys

1. Click Encrypt/Decrypt\Symmetric(modern)\DES(ECB) when CrypTool-en.txt is open. Enter 01 01 01 01 01 01 01 01 as the key.



2. Click “**Encrypt**” button.



3. Repeat step 1 using the same key. Plaintext shows up on the right.