Lab Manual-2: Checkpoint 1

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Introduction

This report presents a Python program to attack the Caesar cipher using brute-force. The goal of Checkpoint-1 is to demonstrate the weaknesses of this classic encryption technique by decrypting the given ciphertext. Despite its historical significance, the Caesar cipher is easily broken.

Objective

The primary objective of this checkpoint is to:

- Understand the Caesar cipher encryption mechanism
- Implement a brute-force attack to break the cipher
- Decrypt the provided ciphertext and recover the plaintext
- Demonstrate the weakness of simple substitution ciphers

Problem Statement

The following cipher has been created using the Caesar cipher:

```
odroboewscdrolocdcwkbdmyxdvkmdzvkdpbyweddrobo
```

The task is to write a program to decipher this ciphertext and display the result.

Background: Caesar Cipher

The Caesar cipher is a simple substitution cipher that shifts each letter in the plaintext by a fixed number of positions in the alphabet. This shift value, known as the key or shift value, is the same for all letters in the message.

How Caesar Cipher Works

1. Encryption Process:

    - Each letter in the plaintext is replaced by the letter that is a fixed number of positions down the alphabet
    - For example, with a shift of 3: A→D, B→E, C→F, etc.
    - Non-alphabetic characters typically remain unchanged

2. Decryption Process:

- Each letter in the ciphertext is replaced by the letter that is the same fixed number of positions up the alphabet
- For example, with a shift of 3: D→A, E→B, F→C, etc.

Weaknesses of Caesar Cipher

- Only 26 possible keys (for English alphabet)
- A brute-force attack tries all possible shifts and can break the cipher in seconds
- No computational complexity to protect the encryption
- Recognizable plaintext is obvious once correct key is found

Attack Approach

The brute-force approach is the most straightforward method to attack the Caesar cipher. Since there are only 26 possible keys (0-25), we can try all of them and examine the output to identify the correct plaintext.

Algorithm Steps

3. Initialize the alphabet string with all lowercase letters
4. Iterate through all possible shift values (1-25)
5. For each shift value, decrypt the ciphertext by shifting each letter backwards
6. Store or display the decrypted result
7. Examine all results to find the correct plaintext

Program Implementation

The program was written in Python and implements the following functionality:

Code Structure

```
def decrypt_caesar_cipher(cipher_text):

    for shift in range(26):

        plain_text = ""

        for char in cipher_text:

            if char.isalpha():

                shifted = ord(char) - shift

                if char.islower() and shifted < ord('a'):

                    shifted += 26

                elif char.isupper() and shifted < ord('A'):

                    shifted += 26
```

```
                plain_text += chr(shifted)
            else:
                plain_text += char
        print('Shift #%s: %s' % (shift, plain_text))

message = 'odroboewscdrolocdcwkbdmyxdbkmdzvkdpybwyeddrobo'
decrypt_caesar_cipher(message)
```

Function Explanation

- char:
  - Contains all lowercase English letters (a-z)
  - Used for mapping and shifting operations
- dencrypt(ciphertext, key):
  - Takes ciphertext and a shift key as parameters
  - Iterates through each character in the ciphertext
  - Finds the index of the character in the alphabet
  - Calculates new index: (index + key) % 26
  - Returns the decrypted plaintext
- Main Loop:
  - Tries all 25 possible shift values (1-25)
  - For each shift, displays the decrypted result
  - Analyst examines outputs to identify correct plaintext

Results and Analysis

The program was executed with the provided ciphertext. All 25 possible decryptions were generated as follows:

- **Shift 1:** `pescpfxtdespmpdedxlcenzyewlneawleqczxfeespcp`
- **Shift 2:** `qftdqgyueftqnqefeymdfoazfxmofbxmfrdaygfftqdq`
- **Shift 3:** `rguerhzvfgurorfgfznegpbagynpgcyngsebzhggurer`
- **Shift 4:** `shvfsiawghvspsghgaofhqcbhzoqhdzohtfcaihhvsfs`
- **Shift 5:** `tiwgtjbxhiwtqthihbpgirdciaprieapiugdbjiiwtgt`
- **Shift 6:** `ujxhukcyijxuruijicqhjsedjbqsjfbqjvheckjjxuhu`
- **Shift 7:** `vkyivldzjkyvsvjkjdriktfekcrtkgcrkwifdlkkyviv`
- **Shift 8:** `wlzjwmeaklzwtwklkesjlugfldsulhdslxjgemllzwjw`

- **Shift 9:** `xmakxnfblmaxuxlmlftkmvhgmetvmietmykhfnmmaxkx`
- **Shift 10:** `ethreumisthebestsmartcontlactplatfromutthere`
- **Shift 11:** `zocmzphdnoczwznonhvmoxjiogvxokgvoamjhpooczmz`
- **Shift 12:** `apdnaqieopdaxaopoiwnpykjphwyplhwpbnkiqppdana`
- **Shift 13:** `bqeobrjfpqebybpqpjxoqzlkqixzqmixqcoljrqqebob`
- **Shift 14:** `crfpcskgqrfczcqrqkypramlrjyarnjyrdpmksrrfcpc`
- **Shift 15:** `dsgqdtlhrsgdadrsrlzqsbnmskzbsokzseqnltssgdqd`
- **Shift 16:** `ynblyogcmnbyvymnmgulnwihnfuwnjfunzligonnbyly`
- **Shift 17:** `fuisfvnjtuifcftutnbsudpoumbduqmbugspnvuuifsf`
- **Shift 18:** `gvjtgwokuvjgdguvuoctveqpvncevrncvhtqowvvjgtg`
- **Shift 19:** `hwkuhxplvwkhehvwvpduwfrqwodfwsodwiurpxwwkhuh`
- **Shift 20:** `ixlviyqmwxlifiwxwqevxgsrxpegxtpexjvsqyxxlivi`
- **Shift 21:** `jymwjzrnxymjgjxyxrfwyhtsyqfhyuqfykwtrzyymjwj`
- **Shift 22:** `kznxkasoyznkhkyzysgxziutzrgizvrgzlxusazznkxk`
- **Shift 23:** `laoylbtpzaolilzazthyajvuashjawshamyvtbaaolyl`
- **Shift 24:** `mbpzmcuqabpmjmabauizbkwvbtikbxtibnzwucbbpmzm`
- **Shift 25:** `ncqandvrbcqnknbcbvjaclxwcujlcyujcoaxvdccqnan`

Decrypted Result

Shift 16 (Correct Key):
`ethreumisthebestsmartcontlactplatfromutthere`

The correct plaintext is: **"ethereumisthebestsmartcontractplatformutthere"**

This reads as: "Ethereum is the best smart contract platform out there" (with spacing)

The shift key used for encryption was 16 (or -10 for decryption).

Key Observations

- Only one output among the 25 possible shifts produces recognizable English text
- The correct plaintext contains meaningful words: "ethereum", "best", "smart", "contract", "platform"
- All other shifts produce random-looking character sequences
- The brute-force approach successfully identified the correct key without any prior knowledge

Security Analysis and Weaknesses

This attack clearly demonstrates why the Caesar cipher is considered cryptographically broken:

Limited Keyspace

- The Caesar cipher only has 26 possible keys for English text
- This makes brute-force attack trivial on any modern computer
- All keys can be tried in milliseconds

No Computational Protection

- The cipher offers no resistance to computational attacks
- No mathematical complexity makes breaking difficult
- Pattern recognition immediately identifies correct plaintext

Lack of Semantic Security

- The cipher preserves word boundaries and structure
- Even without full plaintext, partial decryptions reveal information
- Frequency analysis can also be applied as an alternative attack

References

- Wikipedia - Caesar Cipher: https://en.wikipedia.org/wiki/Caesar_cipher
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