

TP1 Report

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This work has the objective to decipher 3 ciphertexts and do the respective cryptanalysis.

The decrypted results are in the files `plaintext1.txt` , `plaintext2.txt` and `plaintext3.txt` .

The ciphertexts are in uppercase characters and plaintexts in lowercase.

This ciphertexts were encrypted with *affine* , *monoalphabetic substitution* and *Vigenère* (not respectively). Although we didn't know which method of encryption was applied in order, we deduced that the first one wasn't the *Vigenère*, because there were a lot of texts and too few patterns for 3 letter words.

With this we could try to first find the *affine* ciphertext since it's the easiest one to get the key (only 2 numbers obtained from systems of equations with modular arithmetic).

But instead we decided to decypher the *affine* and the *monoalphabetic substitution* at the same time , since the *affine* is a type of *monoalphabetic substitution*.

Ciphertexts #2 & #3

We deciphered these texts with the `mono_decoder` function we developed in python.

This function receives a `ciphertext` (in uppercase) and optionally a `known_letters` map and returns the plaintext if it's possible to decode.

```
mono_decoder(txt, kl={})
```

Important terms:

Confidence

Confidence is a value from `0` to `1` that represents the algorithm's confidence to deduce the word and make changes to the `known_letters` map. This value is just a fraction with the number of `matches` an encrypted word gives.

Match

For an encrypted word 'JGG', swapping uppercase characters for dots (`.`) and passing it to the `match` function developed, it returns a list of possible matched in the `words.txt` file, example:

```
```
```

```
| match('...') ['act', 'add', 'age', 'ago', 'aid', 'aim', 'air', 'all', 'and', 'any', 'are', ...] ```
```

This can be done with a partially encrypted word too. For the word `Joo` passing `.oo` will reduce the number of matches in the result, example:

```
```
```

```
| match('.oo') ['too ] ```
```

Known Letters Map

It's a python dictionary used as a map to store the mapping of the cipher letters to plain letters. Example:

```
known_letters = { 'G':'t', 'U':'a', 'V':'s', 'I':'o', 'T':'r', 'R':'u', 'N':'b', 'O':'l',  
'S':'w', 'H':'i', 'J':'p', 'C':'n', 'B':'m', 'M':'c', 'A':'y', 'K':'g', 'F':'v', 'Z':'f',  
'L':'d', 'L':'d', 'Y':'q', 'P':'k', }
```

Algorithm

This implementation follows a simple algorithm:

1. Swap letters in `txt` with the `known_letters` map (this will increase the confidence in the results)
2. While text is not fully decrypted:
 - 2.1. Find `confidence` and `matches` for every word with any uppercase letter
 - 2.2. Select the word with max `confidence`
 - 2.3. Extract the word selected letters to the `known_letters` map

There's a catch to this algorithm, the results can go very wrong due to two main factors:

- The words file (`words.txt`) could contain insufficient significant words;
- Confidence probability could be low.

Alternative endings

In execution the algorithm can throw an Exception if it can't make any match, if that happens, then that decryption iteration is unviable.

Hints

If the user has any hint of known letters, it should be inserted in the `known_letters` map. Example:

...

```
knownletters = { 'J':'t', # Assuming: JHA -> the, JGG -> too 'G':'o', # Assuming: JHA -> the, JGG -> too 'A':'e', #  
Assuming: JHA -> the, JGG -> too 'H':'h', # Assuming: JHA -> the, JGG -> too 'S':'i', # Hinted by the letter  
frequency swap } monodecoder(ciphertext,kl=known_letters)
```

...

This will reduce the execution time, and improve results due to increased confidence values.

Ciphertext #1

The *Vigenère* cipher was a little harder and with a bit of luck we deciphered it "manually"

The initial take for the cipher was to assume that the initial `WMP` was a `THE`, this was just a hint because it could be another word.

To make the `WMP` become a `THE`, we subtracted the characters to obtain the key for that substitution that was `DFL`.

Decrypting the text with *Vigenère* using only the key `DFL`, at first sight we can capture the presence of the word `our` in the first sentence, this could be a coincidence, but we assumed it wasn't.

The next step we thought was to extend the key with `A`'s to see if any word could be deduced, with 2 `A`'s the result wasn't clear but we could definitely have hints of what words could be in the text, such as `oribgn` for `origin`, `whei` for `when`, `of` ...

'n' + {value} = 'i'

i = 8

n = 13

value = 13-8 = -5

The positive of -5 is 26-5 = 21

21 is the letter **V**

With this information we tried the key **DFLVA**

At this point our intuition was right and the **origgn** word matched almost perfectly so we did one more substitution of the **g** for **i** obtaining **Y**.

The key was now **DFLVY** and we could definitely see the plain text.

The only detail left was the text wasn't fully decrypted so we removed 2 newlines from the ciphertext and all plain text was visible, declaring this as completed.

Final Notes

We also wanted to note that we made a letter frequency attack and tried to swap letters with the most used letters in the english alphabet, but the results were inconclusive.