密码学第一次实验报告

古典密码算法及攻击方法

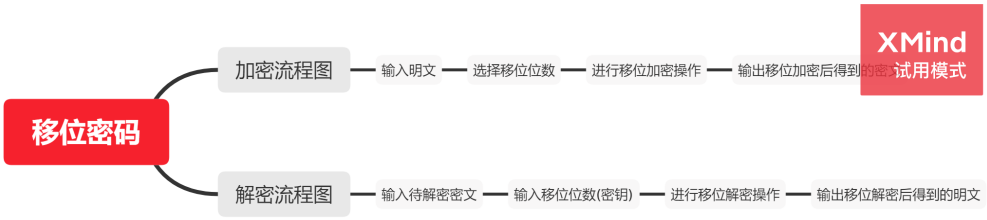
PS：涉及到的项目代码位置导航，移位密码的加密和解密位于**移位密码**文件夹内；单表置换密码的加密解密（自己设计语句作为置换序列首，后顺序排列）位于**单表置换**文件夹内；单表置换密码的攻击我分成了两个代码，首先是对文本中出现字母的统计与文档中提供的相似频率进行匹配，得到一段置换序列，该部分代码位于**单表移位替换**文件夹内，然后是手工对置换序列修改得出明文，此部分实则为上面单表置换加密解密中去除加密部分的代码，为了方便操作单独提出来放在**单表置换改**文件夹中

1. 实验目的

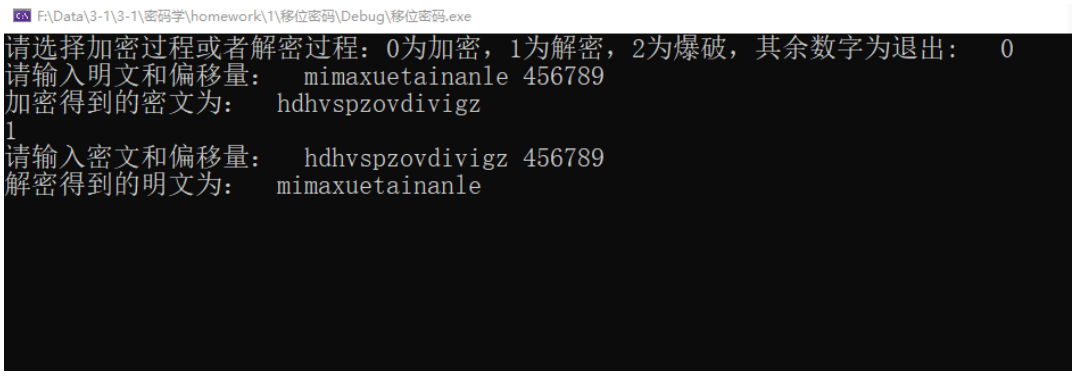
   通过借助C++编程实现移位密码和单表置换密码算法，借助编程的手段进一步加深对经典密码体制的加密和解密体制，并通过这两种密码进行攻击，进一步了解古典密码体制的攻击方法。

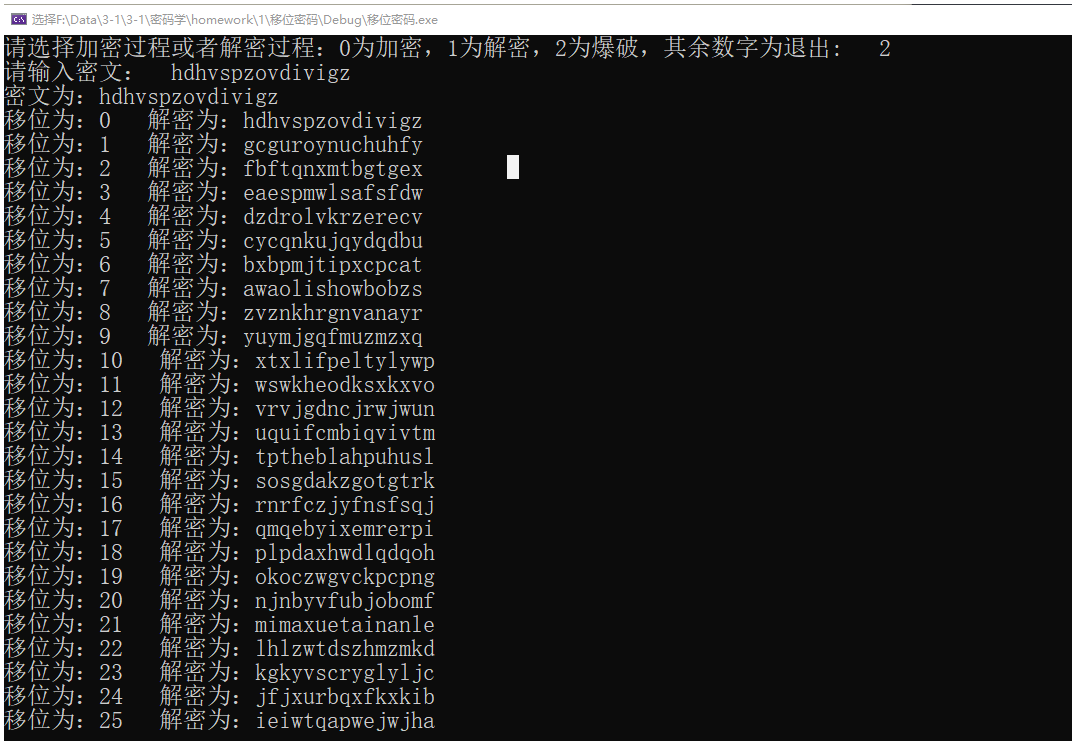
2. 移位密码

   - 加密解密流程图



   - 程序实现结果





- 程序实现代码

```
#include<iostream>
using namespace std;
int get_length(char* text) {
    int i = 0;
    while (text[i] != '\0') {
        i++;
    }
    return i;
}
class shift_crypt {
private:
    int offset;
public:
    shift_crypt() {
        offset = 0;
    }
    shift_crypt(int offset) {
        this->offset = offset;
    }
    char* shift_encrypt(char* plain, int offset) {
        int real_offset = offset % 26;
        int length = get_length(plain);
        char* cipher = new char[length];
        for (int i = 0; i < length; i++) {
            if (plain[i] >= 65 && plain[i] <= 90) {
                int temp = plain[i] + real_offset;
                if (temp > 90)
                    temp -= 26;
                cipher[i] = (char)temp;
                continue;
            }
            if (plain[i] >= 97 && plain[i] <= 122) {
                int temp = plain[i] + real_offset;
                if (temp > 122)
```

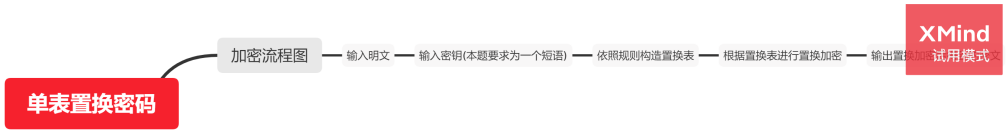
```
                    temp -= 26;
                cipher[i] = (char)temp;
                continue;
            }
            cipher[i] = plain[i]; //非字母的位默认不加密
        }
        cipher[length] = '\0';
        return cipher;
    }
    char* shift_decrypt(char* cipher, int offset) {
        int real_offset = offset % 26;
        int length = get_length(cipher);
        char* plain = new char[length];
        for (int i = 0; i < length; i++) {
            if (cipher[i] >= 65 && cipher[i] <= 90) {
                int temp = cipher[i] - real_offset;
                if (temp < 65)
                    temp += 26;
                plain[i] = (char)temp;
                continue;
            }
            if (cipher[i] >= 97 && cipher[i] <= 122) {
                int temp = cipher[i] - real_offset;
                if (temp < 97)
                    temp += 26;
                plain[i] = (char)temp;
                continue;
            }
            plain[i] = cipher[i]; //非字母的位默认不加密
        }
        plain[length] = '\0';
        return plain;
    }
    void brute_force(char* cipher) {
        cout << "密文为：" << cipher << endl;
        for (int i = 0; i < 26; i++) {
            cout << "移位为：" << i << "    解密为：" <<
shift_decrypt(cipher, i) << endl;
        }
        cout << endl;
    }
};
int main() {
    int flag;
    cout << "请选择加密过程或者解密过程：0为加密，1为解密，2为爆破，其余数字为退出：
  ";
    while (true) {
        cin >> flag;
        if (flag == 0) {
            char* plaintext = new char[100];
            int offset;
            cout << "请输入明文和偏移量：   ";
            cin >> plaintext >> offset;
            shift_crypt encrypt(offset);
            cout << "加密得到的密文为：   " <<
encrypt.shift_encrypt(plaintext, offset) << endl;
        }
        else if (flag == 1) {
```

```
            char* ciphertext = new char[100];
            int offset;
            cout << "请输入密文和偏移量：  ";
            cin >> ciphertext >> offset;
            shift_crypt decrypt(offset);
            cout << "解密得到的明文为：  " <<
decrypt.shift_decrypt(ciphertext, offset) << endl;
        }
        else if (flag == 2) {
            char* ciphertext = new char[100];
            cout << "请输入密文：  ";
            cin >> ciphertext;
            shift_crypt decrypt;
            decrypt.brute_force(ciphertext);
        }
        else {
            break;
        }
    }
    return 0;
}
```

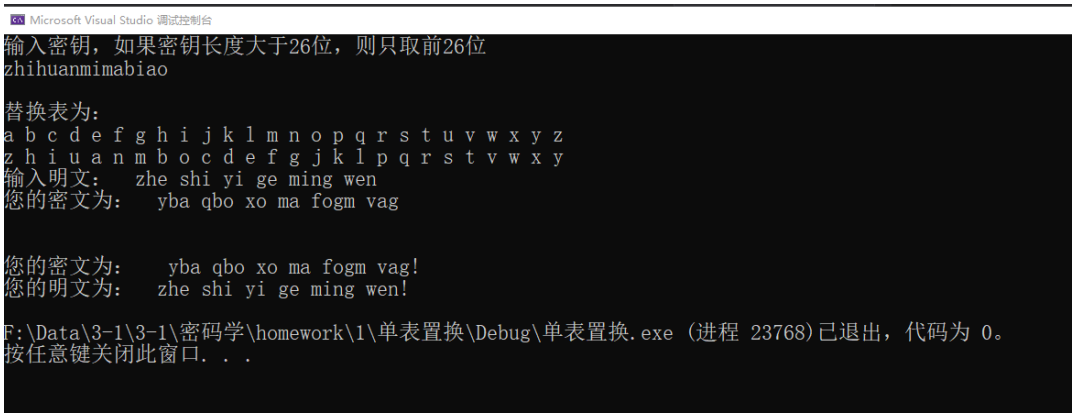
移位密码加密解密以及暴力破解的代码相对而言较为清晰易懂，主要是将每一位char的ascii进行增加或减少，如果因为移位造成超出或者不足字母的ascii范围，对其进行减或加26操作，爆破即offset从0-25依次进行解密操作

3. 单表置换密码

- 加密流程图



- 程序实现结果



- 程序实现代码

```
#include<iostream>
#include<map>
#include<string>
#include<stdio.h>
using namespace std;
int get_length(char* text) {
    int i = 0;
    while (text[i] != '\0') {
```

```
        i++;
    }
    return i;
}
map<char, char> list;
int* a = new int[26];
int main() {
    char* text = new char[100];
    for (int i = 0; i < 26; i++) {
        a[i] = 0;
    }
    cout << "输入密钥，如果密钥长度大于26位，则只取前26位" << endl;
    cin >> text;
    if (get_length(text) > 26) {
        text[26] = '\0';
    }
    //全部改为小写 去重
    int t = 0;
    for (int i = 0; i < get_length(text); i++) {
        text[i] = tolower(text[i]);
        if (text[i] < 97 || text[i] > 122) {
            continue;
        }
        if (a[(int)(text[i] - 'a')]) {
            continue;
        }
        else {
            a[(int)(text[i] - 'a')] = 1;
            list[(char)('a' + t)] = text[i];
            t++;
        }
    }
    for (int j = t; j < 26; j++) {
        char temp = '\0';
        for (int k = 0; k < 26; k++) {
            if (a[k] == 0) {
                a[k] = 1;
                temp = (char)('a' + k);
                break;
            }
        }
        list[(char)('a' + j)] = temp;
    }
    cout << endl << "替换表为：  " << endl;
    for (int j = 0; j < 26; j++) {
        cout << (char)('a' + j) << " ";
    }
    cout << endl;
    for (int j = 0; j < 26; j++) {
        cout << list[(char)('a' + j)] << " ";
    }
    cout << endl;
    char* plaintext = new char[100];
    cout << "输入明文：  ";
    cin.get();
    cin.getline(plaintext,100);
    int len = get_length(plaintext);
    char* ciphertext = new char[len];
```

```
    for (int j = 0; j < len; j++) {
        plaintext[j] = tolower(plaintext[j]);
        if (plaintext[j] < 97 || plaintext[j] > 122) {
            ciphertext[j] = plaintext[j];
        }
        else {
            ciphertext[j] = list.at((char)(plaintext[j]));

        }
    }
    ciphertext[len] = '\0';
    cout << "您的密文为:   " << ciphertext << endl;
    cout << endl << endl;
    cout << "您的密文为:    ";
    cin.getline(ciphertext, 100);
    len = get_length(ciphertext);
    for (int j = 0; j < len; j++) {
        ciphertext[j] = tolower(ciphertext[j]);
        if (ciphertext[j] < 97 || ciphertext[j] > 122) {
            plaintext[j] = ciphertext[j];
        }
        else {
            for (std::map<char, char>::iterator it = list.begin(); it !=
list.end(); it++) {
                if (it->second == ciphertext[j]) {
                    plaintext[j] = it->first;
                }
            }
        }
    }
    plaintext[len] = '\0';
    cout << "您的明文为:   " << plaintext << endl;
    return 0;
}
```

主要借助了C++STL编程中的MAP结构进行操作，默认原字母表为key，置换后为value，因此可以借助at通过key取value，也可以借助iterator迭代器通过value取key（因为构造是无重叠，所以不考虑单value多key的情况）

4. 移位密码的攻击

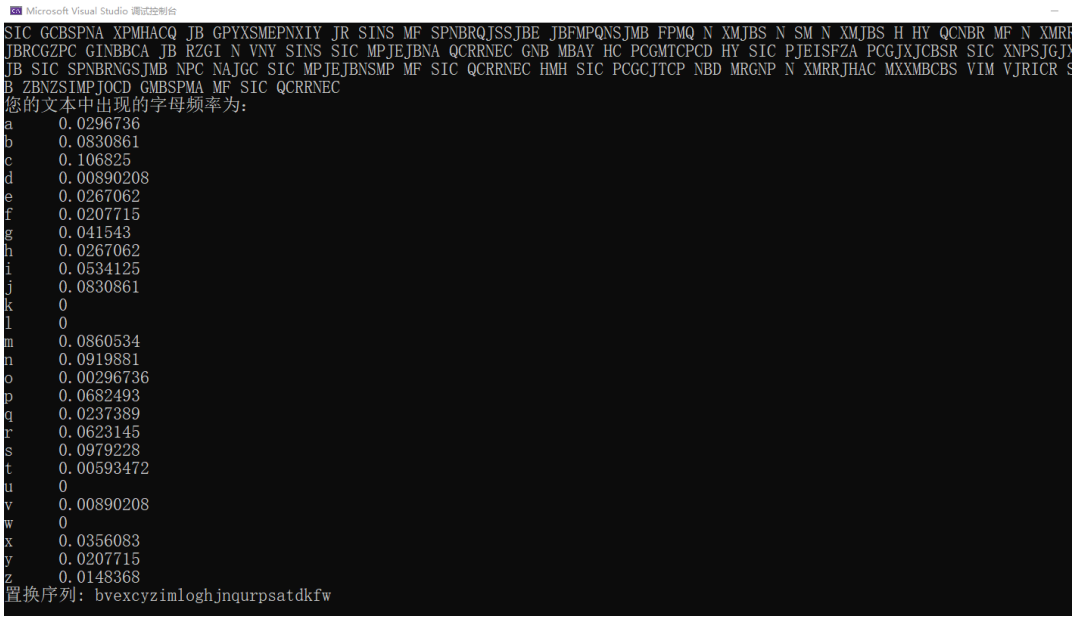
移位密码肯定不适合穷举攻击，在较大规模的数据下，攻击的思路为：将密文中的每个字母出现的频率进行统计，并且和实验文档中给出的自然语言中的字母统计频率进行比较匹配，但是因为给出的文本较为较少，所以我们需要在置换过程后进行校正

各个字母

- 统计字母频率

主要统计密文中出现的字母（默认为小写）的频率，进行排序，与提供的近似频率进行匹配比较得到置换序列，二者均为顺序排序。

```
e  11.67   t  9.53   o  8.22   i  7.81   a  7.73   n  6.71  s  6.55
r  5.97    h  4.52   l  4.3    d  3.24   u  3.21   c  3.06  m  2.8
p  2.34    y  2.22   f  2.14   g  2.00   w  1.69   b  1.58  v  1.03
k  0.79    x  0.30   j  0.23   q  0.12   z  0.09
```



- 置换字母

  随后借助上面单表置换的代码简单精简后进行破译得到相关信息


```
#include<iostream>
#include<string>
using namespace std;
int get_length(char* text) {
    int i = 0;
    while (text[i] != '\0') {
        i++;
    }
    return i;
}
class letter {
private:
    int num;
    char letter_old;
    char letter_new;
public:
    letter() {
        num = 0;
        letter_old = '\0';
        letter_new = '\0';
    }
    letter(char a) {
        num = 0;
        letter_old = a;
        letter_new = '\0';
```

```
    }
    void set_old(char a) {
        letter_old = a;
    }
    void set_num(int a) {
        num = a;
    }
    void num_plus() {
        num++;
    }
    void set_new(char a) {
        letter_new = a;
    }
    char get_old() {
        return letter_old;
    }
    char get_new() {
        return letter_new;
    }
    int get_num() {
        return num;
    }
};
void letter_sort(letter a[]) {
    for (int i = 1; i < 26; i++) {
        for (int j = 0; j < 26 - i; j++) {
            if (a[j].get_num() < a[j + 1].get_num()) {
                char t1 = a[j].get_old();
                a[j].set_old(a[j + 1].get_old());
                a[j + 1].set_old(t1);
                int t2 = a[j].get_num();
                a[j].set_num(a[j + 1].get_num());
                a[j + 1].set_num(t2);
            }
        }
    }
}
int main() {
    char re[27];
    memset(re, '\0', 27);
    letter text_letter[26];
    for (int i = 0; i < 26; i++) {
        text_letter[i].set_old('a' + i);
    }
    cout << "请输入您的文本段:" << endl;
    char* text = new char[1000];
    cin.getline(text, 1000);
    int len = get_length(text);
    double num = 0;
    for (int i = 0; i < len; i++) {
        if (text[i] >= 65 && text[i] <= 90) {
            text_letter[(int)(text[i] - 'A')].num_plus();
            num++;
        }
        if (text[i] >= 97 && text[i] <= 122) {
            text_letter[(int)(text[i] - 'a')].num_plus();
            num++;
        }
```

```
    }
    cout << "您的文本中出现的字母频率为：" << endl;
    for (int i = 0; i < 26; i++) {
        text_letter[i].set_old('a' + i);
        cout << (char)('a' + i) << "     " << (double)
(text_letter[i].get_num() / num) << endl;
    }

    char real_freq[26] = {
'e','t','o','i','a','n','s','r','h','l','d','u','c','m','p','y','f','g',
'w','b','v','k','x','j','q','z' };
    letter_sort(text_letter);
    for (int i = 0; i < 26; i++) {
        text_letter[i].set_new(real_freq[i]);
    }
    for (int i = 0; i < 26; i++) {
        re[text_letter[i].get_new() - 'a'] = text_letter[i].get_old();
    }
    re[26] = '\0';
    cout << "置换序列: " << re;
    cout << endl;
    return 0;
}
```

- 校正

  得到的明文为the leatsou dsimuep na lsfdticsodhf nr thot iy tsoarpnttnac nayispotnia ysip o dinat o ti o dinat m mf peoar iy o dirrnmuf narelgse lhoaaeu na rglh o bof thot the isncnaou perroce loa iauf me selivesew mf the snchtygu selndneatr the dostnlndoatr na the tsoaroltnia ose ounle the isncnaotis iy the perroce mim the selenves oaw irlos o dirrnmue iddiaeat bhi bnrher ti cona gaogthisnkew liatsiu iy the perroce，很明显并不通顺，很明显，单个单词o其实应该是a，所以我们校正置换序列，将o，a所对应的替换密码进行替换，修正置换序列：nvexcyzimloghjbqurpsatdkfw

  得到新的明文为the leotsau dsimuep no lsfdticsadhf nr that iy tsaorpnttnoc noyispatnio ysip a dinot a ti a dinot m mf peaor iy a dirrnmuf norelgse lhaooeu no rglh a baf that the isncnoau perrace lao iouf me selivesew mf the snchtygu selndneotr the dastnlndaotr no the tsaoraltnio ase aunle the isncnoatis iy the perrace mim the selenves aow irlas a dirrnmue iddioeot bhi bnrher ti cano goagthisnkew liotsiu iy the perrace

  我们又看到其中存在iy的存在，所以应该是改成if，即f和y进行交换，校正置换序列：nvexcfzimloghjbqurpsatdkyw

  得到新的明文为：the leotsau dsimuep no lsydticsadhy nr that if tsaorpnttnoc nofispatnio fsip a dinot a ti a dinot m my peaor if a dirrnmuy norelgse lhaooeu no rglh a bay that the isncnoau perrace lao iouy me selivesew my the snchtfgu selndneotr the dastnlndaotr no the tsaoraltnio ase aunle the isncnoatis if the perrace mim the selenves aow irlas a dirrnmue iddioeot bhi bnrher ti cano goagthisnkew liotsiu if the perrace

  我们有发现存在nr that的句子，根据主谓语的关系，应该是is that，所以n与i互换，s与r互换，得到新的置换序列：nvexcfzijloghmbquprsatdkyw

  得到新的明文为：the leotrau drnmuep io lrydtncradhy is that nf traospittioc iofnrpatino frnp a dniot a tn a dniot m my peaos nf a dnssimuy ioselgre lhaooeu io sglh a bay that the nricioau pessace lao nouy me relnverew my the richtfgu relidieots the dartilidaots io the traosaltino are auile the nricioatnr nf the pessace mnm the releiver aow nslar a dnssimue nddnoeot bhn bishes tn caio goagthnrikew lnotrnu nf the pessace

  nf明显为of，所以n和o互换，得到新的置换序列：nvexcfzijloghbmquprsatdkyw

得到新的明文为：the lentrau dromuep in lrydtocradhy is that of transpittinc inforpation frop a doint a to a doint m my peans of a dossimuy inselgre lhanneu in sglh a bay that the oricinau pessace lan onuy me reloverew my the richtfgu relidients the dartilidants in the transaltion are auile the oricinator of the pessace mom the releiver anw oslar a dossimue oddonent bho bishes to cain gnagthorikew lontrou of the pessace

doint改成point，置换序列：nveqcfzijloghbmxuprsatdkyw

得到新的明文为：the lentrau promued in lryptocraphy is that of transdittinc infordation frod a point a to a point m my deans of a possimuy inselgre lhanneu in sglh a bay that the oricinau dessace lan onuy me reloverew my the richtfgu relipients the partilipants in the transaltion are auile the oricinator of the dessace mom the releiver anw oslar a possimue opponent bho bishes to cain gnagthorikew lontrou of the dessace

inforpation->information，probuem->problem，uentral->central，cryptouraphy->cryptography，day->way，unauthoriked->unauthorized。得到新的置换序列为：nhgdcfeijlwaqbmxuprsztvkyo

得到新的明文为：the central problem in cryptography is that of transmitting information from a point a to a point b by means of a possibly insecure channel in such a way that the original message can only be recovered by the rightful recipients the participants in the transaction are alice the originator of the message bob the receiver and oscar a possible opponent who wishes to gain unauthorized control of the message

经过简单审查，该英文能过读顺，破译成功，最终的置换表为