"Assignment-1"

A REPORT SUBMITTED TO

THE NATIONAL INSTITUTE OF ENGINEERING, MYSURU

(An Autonomous Institute under VTU, Belagavi)

In partial fulfilment of the requirements for Cryptography (CS6C02), Sixth Semester

Bachelor of Engineering
in
Computer Science and Engineering

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To

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Question 1.

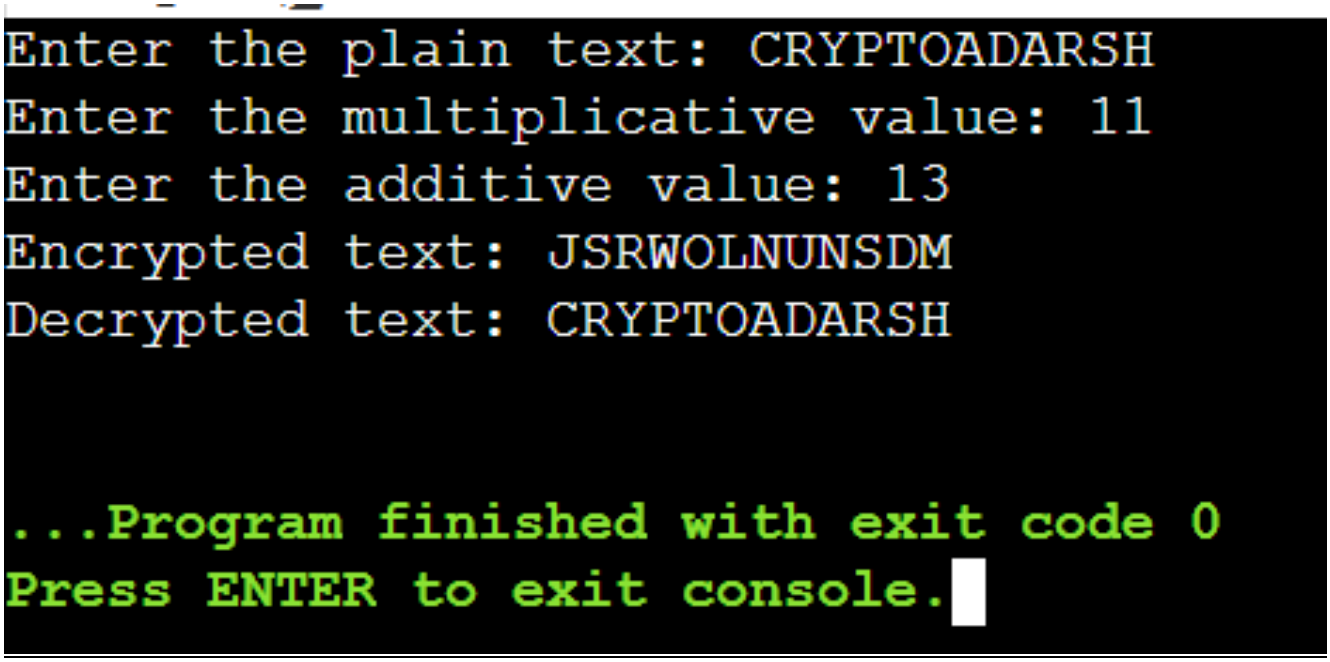
Implement Affine Cipher.

Code:

Code | Blame | 72 lines (60 loc) · 2.15 KB | Raw

```cpp
std::string affine_encrypt(const std::string& plain_text, int a, int b) {
    std::string alphabet = "ABCDEFGHIJKLMNOPQRSTUVWXYZ";
    std::string encrypted_text = "";

    for (size_t i = 0; i < plain_text.length(); i++) {
        char ch = plain_text[i];
        if (std::isalpha(ch)) {
            char uppercase_ch = std::toupper(ch);
            int index = alphabet.find(uppercase_ch);
            int encrypted_index = (a * index + b) % 26;
            char encrypted_char = alphabet[encrypted_index];
            encrypted_text += encrypted_char;
        } else {
            encrypted_text += ch;
        }
    }

    return encrypted_text;
}

std::string affine_decrypt(const std::string& cipher_text, int a, int b) {
    std::string alphabet = "ABCDEFGHIJKLMNOPQRSTUVWXYZ";
    std::string decrypted_text = "";
    int a_inverse = 0;

    for (int i = 0; i < 26; i++) {
        if ((a * i) % 26 == 1) {
            a_inverse = i;
            break;
        }
    }

    for (size_t i = 0; i < cipher_text.length(); i++) {
        char ch = cipher_text[i];
        if (std::isalpha(ch)) {
            char uppercase_ch = std::toupper(ch);
            int index = alphabet.find(uppercase_ch);
            int decrypted_index = (a_inverse * (index - b + 26)) % 26;
            char decrypted_char = alphabet[decrypted_index];
            decrypted_text += decrypted_char;
        } else {
            decrypted_text += ch;
        }
    }

    return decrypted_text;
}

int main() {
    std::string plain_text;
    int a, b;

    std::cout << "Enter the plain text: ";
    std::getline(std::cin, plain_text);
    std::cout << "Enter the multiplicative value: ";
    std::cin >> a;
    std::cout << "Enter the additive value: ";
    std::cin >> b;
    std::cin.ignore();

    std::string encrypted_text = affine_encrypt(plain_text, a, b);
    std::cout << "Encrypted text: " << encrypted_text << std::endl;

    std::string decrypted_text = affine_decrypt(encrypted_text, a, b);
    std::cout << "Decrypted text: " << decrypted_text << std::endl;

    return 0;
}
```

Output:


Enter the plain text: CRYPTOADARSH
Enter the multiplicative value: 11
Enter the additive value: 13
Encrypted text: JSRWOLNUNSDM
Decrypted text: CRYPTOADARSH
...Program finished with exit code 0
Press ENTER to exit console.

Question 2.

Implement Extended Euclidean Algorithm.

Code:

Code | Blame | 55 lines (45 loc) · 1.37 KB | Raw

```cpp
#include <iostream>
#include <stdexcept>

struct ExtendedEuclideanResult {
    int gcd;
    int x;
    int y;
};

ExtendedEuclideanResult extended_euclidean_algorithm(int a, int b) {
    if (b == 0) {
        ExtendedEuclideanResult result;
        result.gcd = a;
        result.x = 1;
        result.y = 0;
        return result;
    }

    ExtendedEuclideanResult prev_result = extended_euclidean_algorithm(b, a % b);
    ExtendedEuclideanResult result;
    result.gcd = prev_result.gcd;
    result.x = prev_result.y;
    result.y = prev_result.x - (a / b) * prev_result.y;

    return result;
}

int find_modular_inverse(int a, int m) {
    ExtendedEuclideanResult result = extended_euclidean_algorithm(a, m);
    if (result.gcd != 1) {
        throw std::runtime_error("Inverse does not exist.");
    }

    int inverse = (result.x % m + m) % m;
    return inverse;
}

int main() {
    int a, m;

    std::cout << "Enter a number to find inverse: ";
    std::cin >> a;
    std::cout << "Enter the number whose modulus is to be found: ";
    std::cin >> m;

    int inverse;
    try {
        inverse = find_modular_inverse(a, m);
        std::cout << "Modular inverse of " << a << " mod " << m << " is: " << inverse << std::endl;
    } catch (const std::runtime_error& e) {
        std::cout << e.what() << std::endl;
    }

    return 0;
}
```

Output:

```
Enter a number to find inverse: 11
Enter the number whose modulus is to be found: 26
Modular inverse of 11 mod 26 is: 19


...Program finished with exit code 0
Press ENTER to exit console.
```

```
Enter a number to find inverse: 12
Enter the number whose modulus is to be found: 26
Inverse does not exist.


...Program finished with exit code 0
Press ENTER to exit console.
```

Question 3.

Select a simple message. Perform a hash function on it.

i) Simulate a receiver computing the hash again and ensuring its integrity.

ii) Slightly change the message. Simulate a receiver computing hash and find it not matching.

Code:

Code | Blame | 40 lines (28 loc) · 1.13 KB | Raw

```cpp
#include <iostream>
#include <string>
#include <random>

int custom_hash(const std::string& message) {
    std::hash<std::string> hash_fn;
    std::size_t hash_value = hash_fn(message);
    return static_cast<int>(hash_value & 0xFFFF);
}

int main() {
    std::string message;

    std::cout << "Enter the message: ";
    std::getline(std::cin, message);

    int hash_value = custom_hash(message);

    std::cout << "Original Message: " << message << std::endl;
    std::cout << "Hash value: " << hash_value << std::endl;


    std::string received_message;
    std::cout << "Enter the received message: ";
    std::getline(std::cin, received_message);

    int received_hash_value = custom_hash(received_message);

    std::cout << "Received Message: " << received_message << std::endl;
    std::cout << "Received Hash value: " << received_hash_value << std::endl;


    if (received_hash_value == hash_value) {
        std::cout << "Integrity: The message has not been modified." << std::endl;
    } else {
        std::cout << "Integrity: The message has been modified." << std::endl;
    }

    return 0;
}
```

Output:

```
Enter the message: CRYPTOADARSH
Original Message: CRYPTOADARSH
Hash value: 47479
Enter the received message: CRYPTOADARSH
Received Message: CRYPTOADARSH
Received Hash value: 47479
Integrity: The message has not been modified.


...Program finished with exit code 0
Press ENTER to exit console.
```

```
Enter the message: CRYPTOADARSH
Original Message: CRYPTOADARSH
Hash value: 47479
Enter the received message: CRYPTOADARH
Received Message: CRYPTOADARH
Received Hash value: 15891
Integrity: The message has been modified.


...Program finished with exit code 0
Press ENTER to exit console.
```

Question 4. a) Create a password file of 10 passwords and use it for identification.

b) Modify one to store the hash values of passwords & use it.

c) Optional: Create a salt file; add salt to password before storing in (b).

Code:

Code Blame 106 lines (91 loc) · 3.98 KB Raw

```cpp
#include <iostream>
#include <fstream>
#include <string>
#include <random>
#include <algorithm>
#include <functional>
#include <cctype>
#include <unordered_map>


std::string generate_salt(std::size_t length = 8) {
    std::string salt_characters = "abcdefghijklmnopqrstuvwxyzABCDEFGHIJKLMNOPQRSTUVWXYZ0123456789!@#$%^&*";
    std::random_device rd;
    std::mt19937 generator(rd());
    std::shuffle(salt_characters.begin(), salt_characters.end(), generator);
    salt_characters.resize(length);
    return salt_characters;
}


std::string hash_password(const std::string& password, const std::string& salt) {
    std::string salted_password = password + salt;
    std::hash<std::string> hash_fn;
    std::size_t hashed_password = hash_fn(salted_password);
    return std::to_string(hashed_password);
}


bool check_password(const std::string& password, const std::string& hashed_password, const std::string& salt) {
    std::string salted_password = password + salt;
    std::hash<std::string> hash_fn;
    std::size_t hashed_input_password = hash_fn(salted_password);
    return hashed_password == std::to_string(hashed_input_password);
}

int main() {
    std::size_t num_users;
    std::cout << "Enter the number of users: ";
    std::cin >> num_users;
    std::cin.ignore(std::numeric_limits<std::streamsize>::max(), '\n');

    std::ofstream file("hashed_passwords.txt");
    if (!file) {
        std::cerr << "Failed to open the file." << std::endl;
        return 1;
    }

    std::unordered_map<std::string, std::string> password_file;
    for (std::size_t i = 1; i <= num_users; ++i) {
        std::string username, password;
        std::cout << "Enter the username for User" << i << ": ";
        std::getline(std::cin, username);
        std::cout << "Enter the password for User" << i << ": ";
        std::getline(std::cin, password);
        password_file[username] = password;
    }

    std::unordered_map<std::string, std::pair<std::string, std::string> > hashed_password_file;
    for (std::pair<const std::string, std::string>& pair : password_file) {
        const std::string& username = pair.first;
        std::string& password = pair.second;
        const std::string salt = generate_salt();
        const std::string hashed_password = hash_password(password, salt);
        hashed_password_file.insert(std::make_pair(username, std::make_pair(hashed_password, salt)));
        file << username << ':' << hashed_password << ':' << salt << '\n';
    }
    file.close();

    std::string input_username, input_password;
    std::cout << "Enter username: ";
    std::getline(std::cin, input_username);
    std::cout << "Enter password: ";
    std::getline(std::cin, input_password);

    std::ifstream hashed_passwords_file("hashed_passwords.txt");
    if (!hashed_passwords_file) {
        std::cerr << "Failed to open the file." << std::endl;
        return 1;
    }

    std::string line;
    bool login_successful = false;
    while (std::getline(hashed_passwords_file, line)) {
        std::size_t delimiter_pos_1 = line.find(':');
        std::size_t delimiter_pos_2 = line.find(':', delimiter_pos_1 + 1);
        if (delimiter_pos_1 != std::string::npos && delimiter_pos_2 != std::string::npos) {
            std::string stored_username = line.substr(0, delimiter_pos_1);
            std::string stored_hashed_password = line.substr(delimiter_pos_1 + 1, delimiter_pos_2 - delimiter_pos_1 - 1);
            std::string stored_salt = line.substr(delimiter_pos_2 + 1);
            if (stored_username == input_username &&
                check_password(input_password, stored_hashed_password, stored_salt)) {
                login_successful = true;
                break;
            }
        }
    }
    hashed_passwords_file.close();

    if (login_successful) {
        std::cout << "Login successful." << std::endl;
    } else {
        std::cout << "Login failed. Invalid username or password." << std::endl;
    }

    return 0;
}
```

Output:

```
local2:13222490781325452142:oPm3hA&v
local1:77723011100628997 21:1ZFDk$Vj

```

```
Enter the number of users: 2
Enter the username for User1: local1
Enter the password for User1: loc1
Enter the username for User2: local2
Enter the password for User2: loc2
Enter username: local1
Enter password: loc1
Login successful.


...Program finished with exit code 0
Press ENTER to exit console.
```

```
Enter the number of users: 2
Enter the username for User1: local1
Enter the password for User1: loc1
Enter the username for User2: local2
Enter the password for User2: loc2
Enter username: local1
Enter password: loc5
Login failed. Invalid username or password.


...Program finished with exit code 0
Press ENTER to exit console.
```

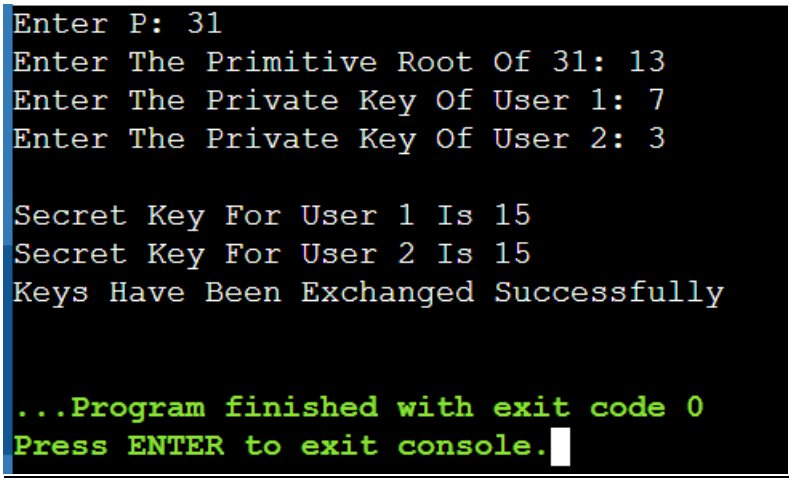
5. Generate a symmetric key by using Diffie-Hellman method given g, p, x and y

Code:

Code | Blame | 104 lines (94 loc) · 2.5 KB | Raw

```cpp
#include <iostream>
#include <vector>
#include <cmath>

int prime_checker(int p) {
    if (p < 1) {
        return -1;
    } else if (p > 1) {
        if (p == 2) {
            return 1;
        }
        for (int i = 2; i < p; ++i) {
            if (p % i == 0) {
                return -1;
            }
        }
        return 1;
    }
    return -1;
}

int primitive_check(int g, int p, std::vector<int>& L) {
    for (int i = 1; i < p; ++i) {
        int result = g;
        for (int j = 1; j < i; ++j) {
            result = (result * g) % p;
        }
        L.push_back(result);
    }
    for (int i = 1; i < p; ++i) {
        if (std::count(L.begin(), L.end(), i) > 1) {
            L.clear();
            return -1;
        }
    }
    return 1;
}

int main() {
    std::vector<int> L;
    int P;
    while (true) {
        std::cout << "Enter P: ";
        std::cin >> P;
        if (prime_checker(P) == -1) {
            std::cout << "Number Is Not Prime, Please Enter Again!" << std::endl;
            continue;
        }
        break;
    }

    int G;
    while (true) {
        std::cout << "Enter The Primitive Root Of " << P << ": ";
        std::cin >> G;
        if (primitive_check(G, P, L) == -1) {
            std::cout << "Number Is Not A Primitive Root Of " << P << ", Please Try Again!" << std::endl;
            continue;
        }
        break;
    }

    int x1, x2;
    while (true) {
        std::cout << "Enter The Private Key Of User 1: ";
        std::cin >> x1;
        std::cout << "Enter The Private Key Of User 2: ";
        std::cin >> x2;
        if (x1 >= P || x2 >= P) {
            std::cout << "Private Key Of Both The Users Should Be Less Than " << P << "!" << std::endl;
            continue;
        }
        break;
    }

    int y1 = 1;
    int y2 = 1;
    for (int i = 0; i < x1; ++i) {
        y1 = (y1 * G) % P;
    }
    for (int i = 0; i < x2; ++i) {
        y2 = (y2 * G) % P;
    }

    int k1 = 1;
    int k2 = 1;
    for (int i = 0; i < x1; ++i) {
        k1 = (k1 * y2) % P;
    }
    for (int i = 0; i < x2; ++i) {
        k2 = (k2 * y1) % P;
    }

    std::cout << "\nSecret Key For User 1 Is " << k1 << std::endl;
    std::cout << "Secret Key For User 2 Is " << k2 << std::endl;

    if (k1 == k2) {
        std::cout << "Keys Have Been Exchanged Successfully" << std::endl;
    } else {
        std::cout << "Keys Have Not Been Exchanged Successfully" << std::endl;
    }

    return 0;
}
```

Output:



Github Link : https://github.com/adarshk0511/CryptoAssignment