Cryptography & Network Security

PRN - 2019BTECS00026

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Batch - B1

Assignment - 12

Title: RSA Algorithm

Aim: To Demonstrate RSA Algorithm

Theory:

RSA (Rivest–Shamir–Adleman) is a public-key cryptosystem that is widely used for secure data transmission.

An RSA user creates and publishes a public key based on two large prime numbers, along with an auxiliary value. The prime numbers are kept secret. Messages can be encrypted by anyone, via the public key, but can only be decoded by someone who knows the prime numbers.

Code:

```
from math import sqrt
import random
from random import randint as rand


def gcd(a, b):
  if b == 0:
    return a
  else:
```

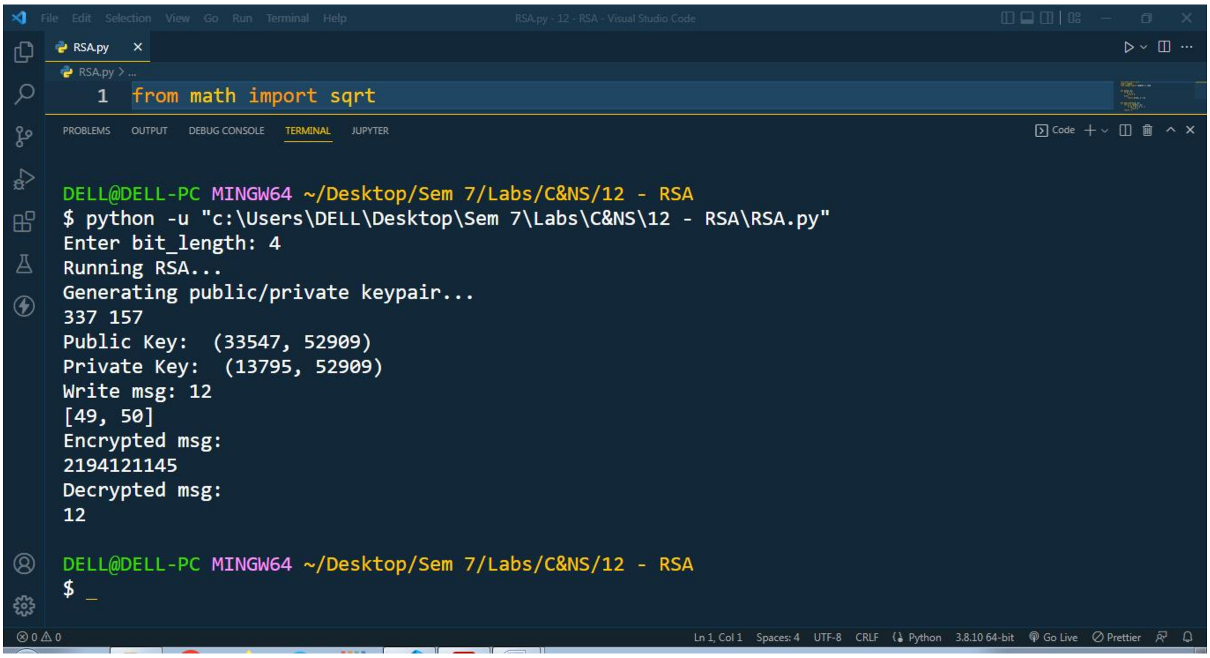
```
        return gcd(b, a % b)


def mod_inverse(a, m):
    for x in range(1, m):
        if (a * x) % m == 1:
            return x
    return -1


def isprime(n):
    if n < 2:
        return False
    elif n == 2:
        return True
    else:
        for i in range(2, int(sqrt(n)) + 1, 2):
            if n % i == 0:
                return False
    return True


p = rand(1, 1000)
q = rand(1, 1000)


def generate_keypair(p, q, keysize):
    nMin = 1 << (keysize - 1)
    nMax = (1 << keysize) - 1
    primes = [2]
```

```python
start = 1 << (keysize // 2 - 1)
stop = 1 << (keysize // 2 + 1)

if start >= stop:
    return []

for i in range(3, stop + 1, 2):
    for p in primes:
        if i % p == 0:
            break
    else:
        primes.append(i)

while (primes and primes[0] < start):
    del primes[0]

while primes:
    p = random.choice(primes)
    primes.remove(p)
    q_values = [q for q in primes if nMin <= p * q <= nMax]
    if q_values:
        q = random.choice(q_values)
        break
print(p, q)
n = p * q
phi = (p - 1) * (q - 1)

e = random.randrange(1, phi)
```

```
    g = gcd(e, phi)

    while True:
        e = random.randrange(1, phi)
        g = gcd(e, phi)
        d = mod_inverse(e, phi)
        if g == 1 and e != d:
            break

    return ((e, n), (d, n))


def encrypt(msg_plaintext, package):
    e, n = package
    msg_ciphertext = [pow(ord(c), e, n) for c in msg_plaintext]
    return msg_ciphertext


def decrypt(msg_ciphertext, package):
    d, n = package
    msg_plaintext = [chr(pow(c, d, n)) for c in msg_ciphertext]
    return (''.join(msg_plaintext))


if __name__ == "__main__":
    bit_length = int(input("Enter bit_length: "))
    print("Running RSA...")
    print("Generating public/private keypair...")
    public, private = generate_keypair(p, q, 2**bit_length)
```

```python
print("Public Key: ", public)

print("Private Key: ", private)

msg = input("Write msg: ")

print([ord(c) for c in msg])

encrypted_msg = encrypt(msg, public)

print("Encrypted msg: ")

print(''.join(map(lambda x: str(x), encrypted_msg)))

print("Decrypted msg: ")

print(decrypt(encrypted_msg, private))
```

Output:



Conclusion:

The security of RSA relies on the practical difficulty of factoring the product of two large prime numbers, the "factoring problem".