Design Document

Description

The purpose of these programs is to create a secure public key cryptography system using RSA encryption. This is asymmetric encryption, where the user's private key is used for decryption and the user's public key is used for anyone to encrypt messages. The two most important functions here are encryption of a message: $E(M) = M^e (mod\ n) = C$, and decryption of a message: $D(C) = C^d (mod\ n) = M$. It is important to note that these functions are inverses, so $E(D(C)) = C$ and $D(E(M)) = M$. Finally, the third program is the keygen program which will be used to generate private and public keys.

Structure

This section contains the pseudocode for the keygen, encryptor, and decryptor.

Keygen

```
func public_key_gen(int n){
p, q = two large primes with ≥ n bits // using Miller-Rabin function
phi = (p-1) * (q-1)
e = random number with ~ n bits
while(gcd(e, phi) > 1){
      e = random number with ~ n bits
}
return p*q, e
}
func private_key_gen(int p, q, e){
      phi = (p-1) * (q-1)
      d = e (mod phi)
      d = 1 / d
      return d
}
u = username
signed = u^d (mod n)
n, e = public_key_gen()
d = private_key_gen()
write_file(n, e)
write_file(d)
print(username, signed, p, q, n, e, d)
```

Encryptor

```
n, e = read(public_key)
if(verbose) print(username, signed, n, e)
s = signature
t = s^e (mod n)
if(t != username){
      return "Error: Invalid signature."
}
rsa_encrypt_file(message)

func rsa_encrypt_file(m) {
      k = [log2(n) - 1] / 8
      int block[k]
      block[0] = '0xFF'
      int read = read k-1 bytes from infile
      while(read > 0) {
            block = number of read bytes
            encrypted = block^e (mod n)
            write_file(encrypted)
      }
}
```

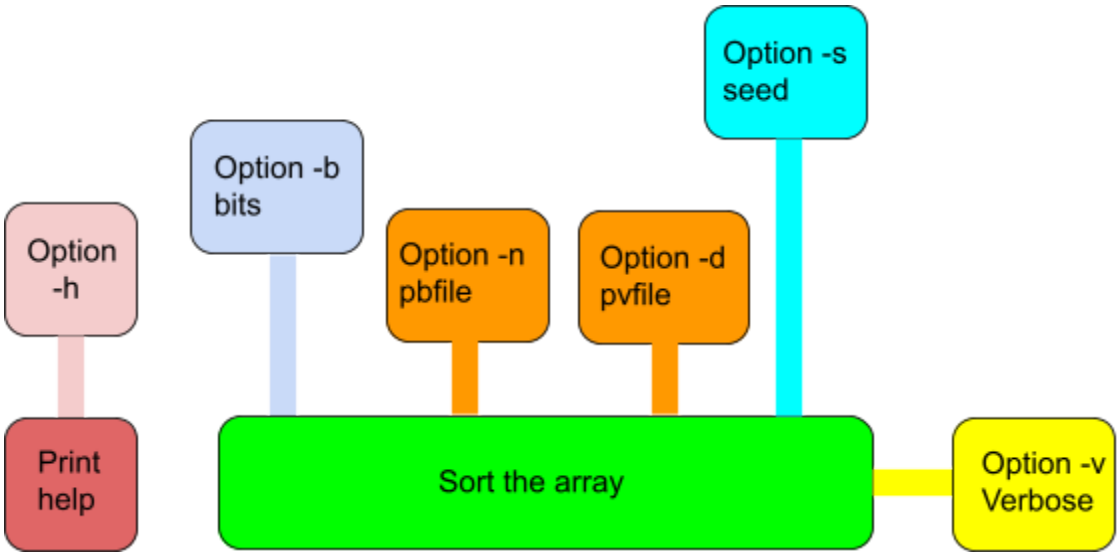
Decryptor

```
d = read(private_key)
if(verbose) print(n, e)
rsa_decrypt_file(message)

func rsa_decrypt_file(m) {
      k = [log2(n) - 1] / 8
      int block[k]
      int read = read read k-1 bytes from infile
      while(read > 0) {
            block = number of read bytes
            decrypted = block^d (mod n)
            write_file(decrypted)
      }
}
```

Inputs and Outputs

Key Generator expected inputs and outputs:



Encryptor/Decryptor expected inputs and outputs: