

Seminar 4 – Cryptography Programming Exercise

Q1: Why did you choose this algorithm?

```
from Crypto.PublicKey import RSA
from Crypto.Cipher import PKCS1_OAEP
from Crypto.Signature import PKCS1_v1_5
from Crypto.Hash import SHA512, SHA384, SHA256, SHA, MD5
from Crypto import Random
from base64 import b64encode, b64decode
import os

hash = 'SHA-256'
key_size = 1024

private_key, get_public_key = b"", b""

def new_keys(key_size):
    random = Random.new().read
    key = RSA.generate(key_size, random)

    private, public = key, key.publickey()
    return private, public

def import_key(key):
    return RSA.importKey(key)

def get_public_key(private_key):
    return private_key.publickey()

def encrypt_file(source, destination):
    cipher = PKCS1_OAEP.new(public_key)

    with open(source, "rb") as src, open(destination, "wb") as dest:
        for chunk in iter(lambda: src.read(80), b''):
            encrypted = cipher.encrypt(chunk)
            dest.write(encrypted)
```

```

def decrypt_file(source, destination):
    cipher = PKCS1_OAEP.new(private_key)

    with open(source, "rb") as src, open(destination, "wt") as dest:
        for chunk in iter(lambda: src.read(128), b''):
            decrypted = cipher.decrypt(chunk).decode('utf-8')
            dest.write(decrypted)

def read_content_as_text(source):
    with open(source, "r") as src:
        print(src.read())

def read_content_as_binary(source):
    with open(source, "rb") as src:
        data = src.read().hex()

        print(data)

private_key, public_key = new_keys(key_size)

if __name__ == "__main__":
    filename = "RSA_SampleText.txt"

    print (f"* Before encryption, content is:\n-----
    -----")
    read_content_as_text(filename)

    # Run the encryption example
    destination = os.path.basename(filename)
    name = destination.split('.', 1)[0]
    extension = destination.split('.', 1)[1]
    destination = name + ".encrypt." + extension
    print (f"\n* Encrypting file to: {destination}...\n-----
    -----")

    encrypt_file(filename, destination)

    print (f"\n* After encryption, content is:\n-----
    -----")
    read_content_as_binary(destination)

    # Run the decryption example
    destination2 = name + ".decrypt." + extension

```

```

decrypt_file(destination, destination2)

print (f"\n* After decryption, content is:\n-----
-----")
read_content_as_text(destination2)

```

Program Output

* Before encryption, content is:

"RSA (Rivestâ€™Shamirâ€™Adleman) is an algorithm used by modern computers to encrypt and decrypt messages. It is an asymmetric cryptographic algorithm. Asymmetric means that there are two different keys. This is also called public key cryptography, because one of the keys can be given to anyone. The other key must be kept private. The algorithm is based on the fact that finding the factors of a large composite number is difficult: when the factors are prime numbers, the problem is called prime factorization. It is also a key pair (public and private key) generator. RSA involves a public key and private key. The public key can be known to everyone- it is used to encrypt messages. Messages encrypted using the public key can

only be decrypted with the private key. The private key needs to be kept secret. Calculating the private key from the public key is very difficult."

Source: https://simple.wikipedia.org/wiki/RSA_algorithm

* Encrypting file to: RSA_SampleText.encrypt.txt...

* After encryption, content is:

```

a59c5c5b7de123e091d1e6c1d2445d0e41763e4c1484604f392c813f98cfd4971cc88b17f
7038c1bd313e861066ba172c6363c0693dc970163d66f7f4d27a0ec32c7899341090bf2c7
63e38aee57be5eb7f15fe10ff69b243cfcdbdcfd7de4a695293f6ebabff95f6e0f27b72f8
15bb28c15e1a4ea427fd253fec78a6ab67afdaca77cf777a6bc7db9d69b2c3d8d8fc803b9
ca4d594d0b3cf2bd8bcb682d2abf4744512240807fa2a3ac82dd6ff044cf20a033f7eae16
54b552443c5159b85b0830b7d0baf5fc08bde60b41812a5ef264b42420d3a03cae8fb4f46
efa42db3f222a0585985d807fb0b738ba1b1f11f235a425cd4e3439ebbd70415382a3edc9
2674290e5fc357d0fd19f6fb5c64e28946e16ecbdb27b579dbb529686f5e813890cab7bce
c4bbbed25621d953d5e3df428d95cdc1ee9a925051221dd20843374cfebc246449e17e50e4

```

```
f187a3b38e88c35ef0f62dd3203a5e1fb7994be99330de72b5f16c5afafc6c74e7a4bdbcc
c20111b9ab5afad45f14f2dd37cc00b01296cb539b4a78b80ed88cd73bea5096841ffcc90
5e4d188022221e4279fe9096ebd23b89022e188c106d46f33313c514f7a488b1eb4cd1279
f6f35270adb57cf043e57f3010a0ccfd93729065cb7a498f0a20aa08abbde4cd4ff8511d6
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c55f34c11e2ecd0a2f81a081dd074e807e334d93274d1485746998e1b01ce2485e97fbab5
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d2f217dde552acd120b4634e69136417109e6271c57aecc677506d631a3e47fcd9fbd0d47
acef7413ea7214a78da76a0432357f796f51c53bf08948ebdc43716f54b6f8417ac214eca
d864e1b4519b2258a0eddf016f73480bfd2721012b3e65fc2cd8c5b249420fe1dd2cc0457
cf3e2a98c7a5df8f7c224caca0bd0f2f748d3e3d60335934b9a662310c58a165fa2704ac9
95248c28cbd65951c5a89ae0164068c6d35c3cdd868736666322135c8b864bf3d62188f90
94fca7f0274f57cef832b3ff85045ec96be2a127850ec7fc2a9f6524d59e87dac867b504b
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6d001a6b4f1fd7ef8dfa8e39d07bdb9cdf2cc4e4dd478d1ce8a308d9b43c583c027f7b783
38415131f018188aff459a88311cdf91dc0f3dbc524df863f9975266e3559bfb5f8eb4b7a
c593e9560bf5b67c7292235ddd8fffb18e64f8645bf79353d90a402215d21b0fd29d8c1c78
f8503c96319dc5ff80f873509e7e5eeb2095c841bcf30b4c33ebc3a7ed894dee5cf431f70
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ba164800db188fb8d1bfbce2e4a9f04abeaac7672625c22f7dfb2a5d31f002b8c6bac005c
9cf5ad46b16ad2f464de78749ac847f0ca6ce340e235bb91327c291dfac3c6e090fc76382
336ff9e3fc309190f2f6a40e963ca2b1f6dfa1d81e18d91905dcd6f7f1b6e86d00342b4c9
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d6aaf6fbc511bc678c7b52f5177bd342b21403197f0b5e94a8c09e7d199a94794c8e6cc83
1c449647672904d15228be32b838e9f297b5886c7a336963a517a4f8060f2814b51f7dd8f
88ef30
```

* After decryption, content is:

"RSA (Rivest-Shamir-Adleman) is an algorithm used by modern computers to encrypt and decrypt messages. It is an asymmetric cryptographic algorithm. Asymmetric means that there are two different keys. This is also called public key cryptography, because one of the keys can be given to anyone. The other key must be kept private. The algorithm is based on the fact that finding the factors of a large composite number is difficult: when the factors are prime numbers, the problem is called prime factorization. It is also a key pair (public and private key) generator. RSA involves a public key and private key. The public key can be

known to everyone- it is used to encrypt messages. Messages encrypted using the public key can only be decrypted with the private key. The private key

needs to be kept secret. Calculating the private key from the public key is very difficult.”

Source: https://simple.wikipedia.org/wiki/RSA_algorithm

I chose the RSA algorithm for file encryption, with a key size of 1024 bits. Several easily searchable articles on the internet refer users to use the Fernet algorithm (PyShark, n.d) (CodersHubb, n.d). The appeal for the Fernet algorithm is that it is easy to implement and use (Buchanan, 2018), which uses 128-bit AES in CBC mode and PKCS7 padding. Many of today’s CPUs (Intel) have in-built support for AES (Intel, 2012). Even Microsoft’s latest update supports AES encryption to protect their MS-SAMR protocol (Microsoft, 2021).

However, a major *downside* to using the Fernet algorithm is that the data to encrypt must fit inside computer memory. Fernet is therefore unsuitable for files that may exceed a few hundred megabytes in size. RSA, in comparison, can handle almost limitless blocks of data, albeit it at the cost of performance. `encrypt_file` and `decrypt_file` demonstrate how to leverage the RSA encryption and decryption routines on potentially large files. Another factor in selecting RSA is use of **public key** and **private key** pairs, thereby ensuring an even higher level of security of the encrypted data. However, the downside is that encryption-key management becomes more critical than the simpler Fernet algorithm.

Q2: Does the algorithm meet GDPR?

While GDPR covers a wide range of requirements related to the processing and storage of data, the selected algorithm most can be leveraged in the *anonymisation* of personal data and can therefore be safely employed in data protection policies. According to Hambley (2019), Article 33 does not apply if encrypted data is lost and the keys to the encrypted data have been breached. In such a scenario, the breach is treated as an unencrypted data breach. He also makes an argument that destruction of keys related to encrypted data is the same as destroying the data itself. Therefore, leveraging a strong encryption algorithm such as RSA is very suitable for use with GDPR protection policies.

Article 32(1) of the General Data Protection Regulations places the responsibility for protecting personal data on the data controller but does not define what steps must be

takes to ensure suitable technical measures are adopted to protection of said data. Coos (2021) points out that GDPR does not mandate for use of encryption, but that it is referenced at least four times within the regulation as a recommendation and as an effective technical measure.

References

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