資訊安全作業 Assignment1

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1 安裝 Python Packages

1.1 使用終端機安裝 pip

打開 terminal 後，先輸入指令安裝 pip
sudo easy_install pip

```
$ sudo easy_install pip
Password:
Searching for pip
Reading https://pypi.python.org/simple/pip/
Best match: pip 9.0.1
Downloading https://pypi.python.org/packages/11/b6/abcb525026a4be042b486df43905d6893fb04f0
5aac21c32c638e939e447/pip-9.0.1.tar.gz#md5=35f01da33009719497f01a4ba69d63c9
Processing pip-9.0.1.tar.gz
Writing /tmp/easy_install-DLIR6I/pip-9.0.1/setup.cfg
Running pip-9.0.1/setup.py -q bdist_egg --dist-dir /tmp/easy_install-DLIR6I/pip-9.0.1/egg-
dist-tmp-igNVh8
/System/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.7/distutils/dist.py:2
67: UserWarning: Unknown distribution option: 'python_requires'
  warnings.warn(msg)
warning: no previously-included files found matching '.coveragerc'
warning: no previously-included files found matching '.mailmap'
warning: no previously-included files found matching '.travis.yml'
warning: no previously-included files found matching '.landscape.yml'
warning: no previously-included files found matching 'pip/_vendor/Makefile'
warning: no previously-included files found matching 'tox.ini'
warning: no previously-included files found matching 'dev-requirements.txt'
warning: no previously-included files found matching 'appveyor.yml'
no previously-included directories found matching '.github'
no previously-included directories found matching '.travis'
no previously-included directories found matching 'docs/_build'
no previously-included directories found matching 'contrib'
no previously-included directories found matching 'tasks'
no previously-included directories found matching 'tests'
creating /Library/Python/2.7/site-packages/pip-9.0.1-py2.7.egg
Extracting pip-9.0.1-py2.7.egg to /Library/Python/2.7/site-packages
Adding pip 9.0.1 to easy-install.pth file
Installing pip script to /usr/local/bin
Installing pip2.7 script to /usr/local/bin
Installing pip2 script to /usr/local/bin

Installed /Library/Python/2.7/site-packages/pip-9.0.1-py2.7.egg
Processing dependencies for pip
Finished processing dependencies for pip
```

Figure 1: 安裝 pip

接著輸入下圖指令，安裝需要的 package
這邊是安裝 cryptography，版本為 1.8.1
sudo pip install packagename==version
packagename：要安裝的 package 名稱
version：要安裝的版本號碼

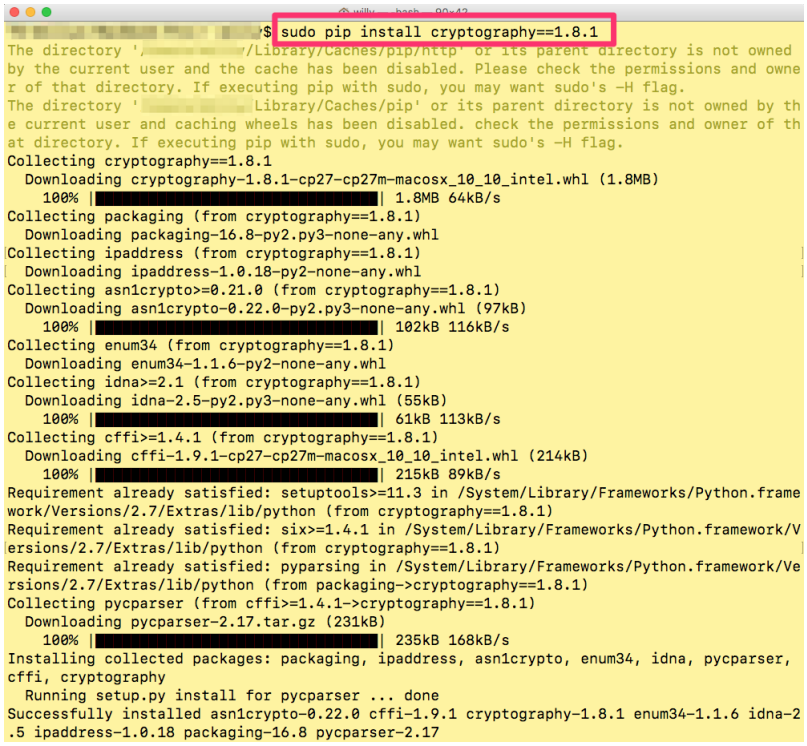
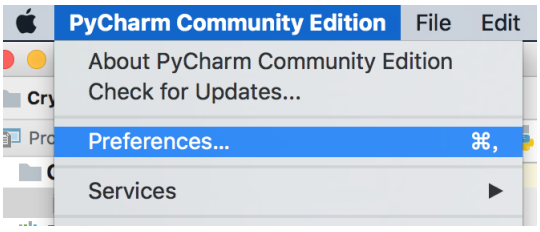


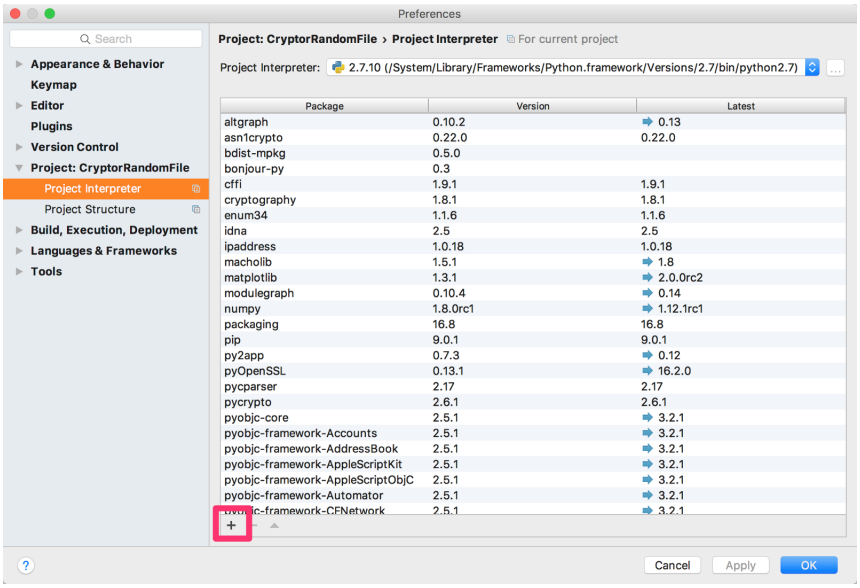
Figure 2: 安裝 package

1.2 使用 PyCharm

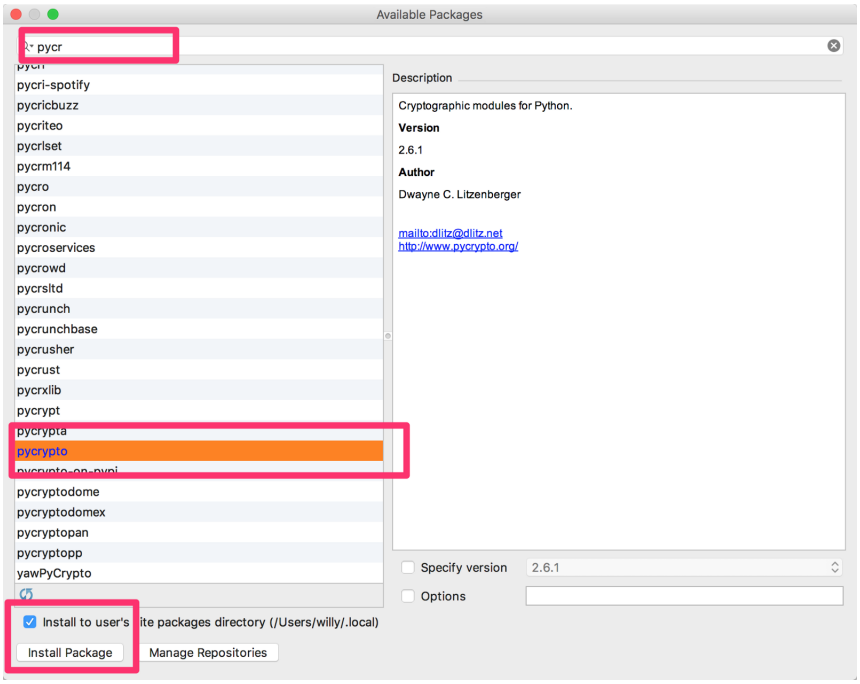
打開 PyCharmCE，先點選 Preferences...



選擇 Project: ProjectName » Project Interpreter » +



輸入要加入的 package name



2 PyCrypto

2.1 PyCrypto AES-256 ECB

```
# -*- coding: utf-8 -*-

from __future__ import absolute_import, division, unicode_literals

import os
from Crypto.Cipher import AES

_KEY = os.urandom(32)              # 設定Key
_BlockSize = AES.block_size        # Block Size

#padding
_Pad = lambda s: s + (_BlockSize - len(s) % _BlockSize) *
        chr(_BlockSize - len(s) % _BlockSize)
_Unpad = lambda s : s[0:-ord(s[-1])]

# 使用ECB加密
def aes_encrypt(data):
    cryptor = AES.new(_KEY, AES.MODE_ECB)
    return cryptor.encrypt(_Pad(data))

# 使用ECB解密
def aes_decrypt(data):
    cryptor = AES.new(_KEY, AES.MODE_ECB)
    return _Unpad(cryptor.decrypt(data))
```

2.2 PyCrypto AES-256 CBC

```
# -*- coding: utf-8 -*-

from __future__ import absolute_import, division, unicode_literals

import os
from Crypto.Cipher import AES
```

```
_IV = os.urandom(16)                # 產生隨機亂數IV
_KEY = os.urandom(32)               # 設定Key
_BlockSize = AES.block_size         # Block Size

#padding
_Pad = lambda s: s + (_BlockSize - len(s) % _BlockSize) *
        chr(_BlockSize - len(s) % _BlockSize)
_Unpad = lambda s : s[0:-ord(s[-1])]

# 使用CBC加密
def aes_encrypt(data):
    cryptor = AES.new(_KEY, AES.MODE_CBC, _IV)
    return cryptor.encrypt(_Pad(data))

# 使用CBC解密
def aes_decrypt(data):
    cryptor = AES.new(_KEY, AES.MODE_CBC, _IV)
    return _Unpad(cryptor.decrypt(data))
```

2.3 PyCrypto AES-256 CTR

```
# -*- coding: utf-8 -*-

from __future__ import absolute_import, division, unicode_literals

import os
from Crypto.Cipher import AES

_IV = os.urandom(16)                # 產生隨機亂數IV
_KEY = os.urandom(32)               # 設定Key
_COUNTER = os.urandom(16)
_BlockSize = AES.block_size # Block Size

#padding
_Pad = lambda s: s + (_BlockSize - len(s) % _BlockSize) *
        chr(_BlockSize - len(s) % _BlockSize)
_Unpad = lambda s : s[0:-ord(s[-1])]

# 使用CTR加密
```

```
def aes_encrypt(data):
    cryptor = AES.new(_KEY, AES.MODE_CTR, counter=lambda: _COUNTER)
    return cryptor.encrypt(_Pad(data))

# 使用CTR解密
def aes_decrypt(data):
    cryptor = AES.new(_KEY, AES.MODE_CTR, counter=lambda: _COUNTER)
    return _Unpad(cryptor.decrypt(data))
```

2.4 PyCrypto RSA-2048

```
# 使用RSA加密
def rsa_encrypt(data):
    encrypted = _PUBLICKEY.encrypt(_Pad(data), 16)
    return encrypted

# 使用RSA解密
def rsa_decrypt(data):
    decrypted = _KEY.decrypt(data)
    return _Unpad(decrypted)
```

2.5 PyCrypto SHA-512

```
# -*- coding: utf-8 -*-
from __future__ import absolute_import, division, unicode_literals

from Crypto.Hash import SHA512

def hashSHA512(data):
    hash = SHA512.new()
    hash.update(data)
    return hash.hexdigest()
```

3 Cryptography

3.1 Cryptography AES-256 ECB

```
import os
from cryptography.hazmat.primitives.ciphers import Cipher,
        algorithms, modes
from cryptography.hazmat.backends import default_backend

backend = default_backend()
_KEY = os.urandom(32)    # 設定Key
_BlockSize = 16          # Block Size

#padding
_Pad = lambda s: s + (_BlockSize - len(s) % _BlockSize) *
        chr(_BlockSize - len(s) % _BlockSize)
_Unpad = lambda s : s[0:-ord(s[-1])]

# 使用ECB加密
def aes_encrypt(data):
    cipher = Cipher(algorithms.AES(_KEY), modes.ECB(), backend=backend)
    encryptor = cipher.encryptor()
    ciphertext = encryptor.update(_Pad(data))
    return ciphertext

# 使用ECB解密
def aes_decrypt(data):
    cipher = Cipher(algorithms.AES(_KEY), modes.ECB(), backend=backend)
    decryptor = cipher.decryptor()
    plaintext = _Unpad(decryptor.update(data))
    return plaintext
```

3.2 Cryptography AES-256 CBC

```
import os
from cryptography.hazmat.primitives.ciphers import Cipher,
        algorithms, modes
from cryptography.hazmat.backends import default_backend
```

```
backend = default_backend()
_IV = os.urandom(16)     # 產生隨機亂數IV
_KEY = os.urandom(32)    # 設定Key
_BlockSize = 16          # Block Size

#padding
_Pad = lambda s: s + (_BlockSize - len(s) % _BlockSize) *
        chr(_BlockSize - len(s) % _BlockSize)
_Unpad = lambda s : s[0:-ord(s[-1])]

# 使用CBC加密
def aes_encrypt(data):
    cipher = Cipher(algorithms.AES(_KEY), modes.CBC(_IV),
        backend=backend)
    encryptor = cipher.encryptor()
    ciphertext = encryptor.update(_Pad(data))
    return ciphertext

# 使用CBC解密
def aes_decrypt(data):
    cipher = Cipher(algorithms.AES(_KEY), modes.CBC(_IV),
        backend=backend)
    decryptor = cipher.decryptor()
    plaintext = _Unpad(decryptor.update(data))
    return plaintext
```

3.3 Cryptography AES-256 CTR

```
import os
from cryptography.hazmat.primitives.ciphers import Cipher,
        algorithms, modes
from cryptography.hazmat.backends import default_backend

backend = default_backend()
_IV = os.urandom(16)     # 產生隨機亂數IV
_KEY = os.urandom(32)    # 設定Key
_BlockSize = 16          # Block Size
```

```
#padding
_Pad = lambda s: s + (_BlockSize - len(s) % _BlockSize) *
        chr(_BlockSize - len(s) % _BlockSize)
_Unpad = lambda s : s[0:-ord(s[-1])]

# 使用CTR加密
def aes_encrypt(data):
    cipher = Cipher(algorithms.AES(_KEY), modes.CTR(_IV),
        backend=backend)
    encryptor = cipher.encryptor()
    ciphertext = encryptor.update(_Pad(data))
    return ciphertext

# 使用CTR解密
def aes_decrypt(data):
    cipher = Cipher(algorithms.AES(_KEY), modes.CTR(_IV),
        backend=backend)
    decryptor = cipher.decryptor()
    plaintext = _Unpad(decryptor.update(data))
    return plaintext
```

3.4 Cryptography RSA-2048

```
def rsa_encrypt(data):
    # ciphertext= ''
    for text in data:
        cipher = _PUBLICKEY.encrypt(
        text,
        padding.OAEP(
            mgf=padding.MGF1(algorithm=hashes.SHA1()),
            algorithm=hashes.SHA1(),
            label=None
            )
        )
```

3.5 Cryptography SHA-512

```
from cryptography.hazmat.primitives import hashes
from cryptography.hazmat.backends import default_backend

backend = default_backend()

def hashSHA512(data):
    digest = hashes.Hash(hashes.SHA512(), backend=default_backend())
    digest.update(data)
    return digest.finalize()
```

4 PyCrypto 與 Cryptography 加密的執行速度

利用 Python 隨機產生一個大小為 1MB+7byte 的字串檔案並且丟到每一個加密演算法計算時間

4.1 隨機產生字串檔案

```
# -*- coding: utf-8 -*-
import random, string

# 隨機產生大小為 size 的字串檔案
def generateStringFile(size):
    text = ''.join(random.choice(string.ascii_letters +
        string.digits) for x in range(size))
    file = open('RandomString.txt', 'wb')
    file.write(text)
```

4.2 AES-256 ECB

```
# PyCrypto_AES_256_ECB
print ('PyCrypto_AES_256_ECB')
start = time.time()
encrypt = PyCrypto_AES_256_ECB.aes_encrypt(plaintext)
end = time.time()
elapsed = end - start
print ('Time taken: ' + str(elapsed) + 'seconds.')

# Cryptography_AES_256_ECB
print ('Cryptography_AES_256_ECB')
start = time.time()
encrypt = Cryptography_AES_256_ECB.aes_encrypt(plaintext)
end = time.time()
elapsed = end - start
print ('Time taken: ' + str(elapsed) + 'seconds.')
```

輸出的結果為
PyCrypto AES256 ECB Time taken: 0.00929403305054seconds.
Cryptography AES256 ECB Time taken: 0.00262188911438seconds.

4.3 AES-256 CBC

```
# PyCrypto_AES_256_CBC
print ('PyCrypto_AES_256_CBC')
start = time.time()
encrypt = PyCrypto_AES_256_CBC.aes_encrypt(plaintext)
end = time.time()
elapsed = end - start
print ('Time taken: ' + str(elapsed) + 'seconds.')

# Cryptography_AES_256_CBC
print ('Cryptography_AES_256_CBC')
start = time.time()
encrypt = Cryptography_AES_256_CBC.aes_encrypt(plaintext)
end = time.time()
elapsed = end - start
print ('Time taken: ' + str(elapsed) + 'seconds.')
```

輸出的結果為
PyCrypto AES256 CBC Time taken: 0.0101928710938seconds.
Cryptography AES256 CBC Time taken: 0.00265407562256seconds.

4.4 AES-256 CTR

```
# PyCrypto_AES_256_CTR
print ('PyCrypto_AES_256_CTR')
start = time.time()
encrypt = PyCrypto_AES_256_CTR.aes_encrypt(plaintext)
end = time.time()
elapsed = end - start
print ('Time taken: ' + str(elapsed) + 'seconds.')

# Cryptography_AES_256_CTR
```

```
print ('Cryptography_AES_256_CTR')
start = time.time()
encrypt = Cryptography_AES_256_CTR.aes_encrypt(plaintext)
end = time.time()
elapsed = end - start
print ('Time taken: ' + str(elapsed) + 'seconds.')
```

輸出的結果為

PyCrypto AES256 CTR Time taken: 0.0238711833954seconds.
Cryptography AES256 CTR Time taken: 0.000817060470581seconds.

4.5 RSA-2048

```
# PyCrypo_RSA_2048
print ('PyCrypo RSA2048')
start = time.time()
encrypt = PyCrypo_RSA_2048.rsa_encrypt(plaintext)
end = time.time()
elapsed = end - start
print ('Time taken: ' + str(elapsed) + 'seconds.')

# Cryptography_RSA_2048
print ('Cryptography RSA2048')
start = time.time()
encrypt = Cryptography_RSA_2048.rsa_encrypt(plaintext)
end = time.time()
elapsed = end - start
print ('Time taken: ' + str(elapsed) + 'seconds.')
```

輸出的結果為

PyCrypo RSA2048 Time taken: 103.83675909seconds.
Cryptography RSA2048 Time taken: 87.8018479347seconds.

4.6 SHA-512

```
# PyCrypo_SHA_512
print ('PyCrypo_SHA_512')
```

```
start = time.time()
hash = PyCrypo_SHA_512.hashSHA512(plaintext)
end = time.time()
elapsed = end - start
print ('Time taken: ' + str(elapsed) + 'seconds.')

# Cryptography_SHA_512
print ('Cryptography_SHA_512')
start = time.time()
hash = Cryptography_SHA_512.hashSHA512(plaintext)
end = time.time()
elapsed = end - start
print ('Time taken: ' + str(elapsed) + 'seconds.')
```

輸出的結果為

PyCrypo SHA512 Time taken: 0.0035879611969seconds.
Cryptography SHA512 Time taken: 0.00237917900085seconds.

5 比較 PyCrypto 與 Cryptography 的加密執行速度

5.1 隨機產生大小為 1MB+7byte 的字串檔案

	ECB	CBC	CTR	RSA2048	SHA512
PyCrypto	0.00929	0.01019	0.02387	103.83676	0.00359
Cryptography	0.00262	0.00265	0.00081	60.44971	0.00238

5.2 隨機產生大小為 512MB+7byte 的字串檔案

	ECB	CBC	CTR	RSA2048	SHA512
PyCrypto	5.21309	5.64221	13.40350	—	1.96496
Cryptography	1.22992	2.13249	1.34670	—	1.24736

6 結論

依照加密演算法來看 SHA512 > AES > RSA248。
其中，SHA>AES 我想應該是因為 SHA 不需考慮解密，所以演算法的效率就可以比 AES 來得高。
而 AES>RSA2048 則是可以預期的結果，而且 RSA 在實務上也不會對字串作加密。
另外，Cryptography 速度也都比 PyCrypto 來得快。

以上內容以及程式碼可以參考我的 github 以及 medium
https://github.com/WillyWu0201/CryptorRandomFile
https://medium.com/@willywu/%E5%88%A9%E7%94%A8pip%E5%AE%89%E8%A3%9Dpython-package-dc3e82348c29