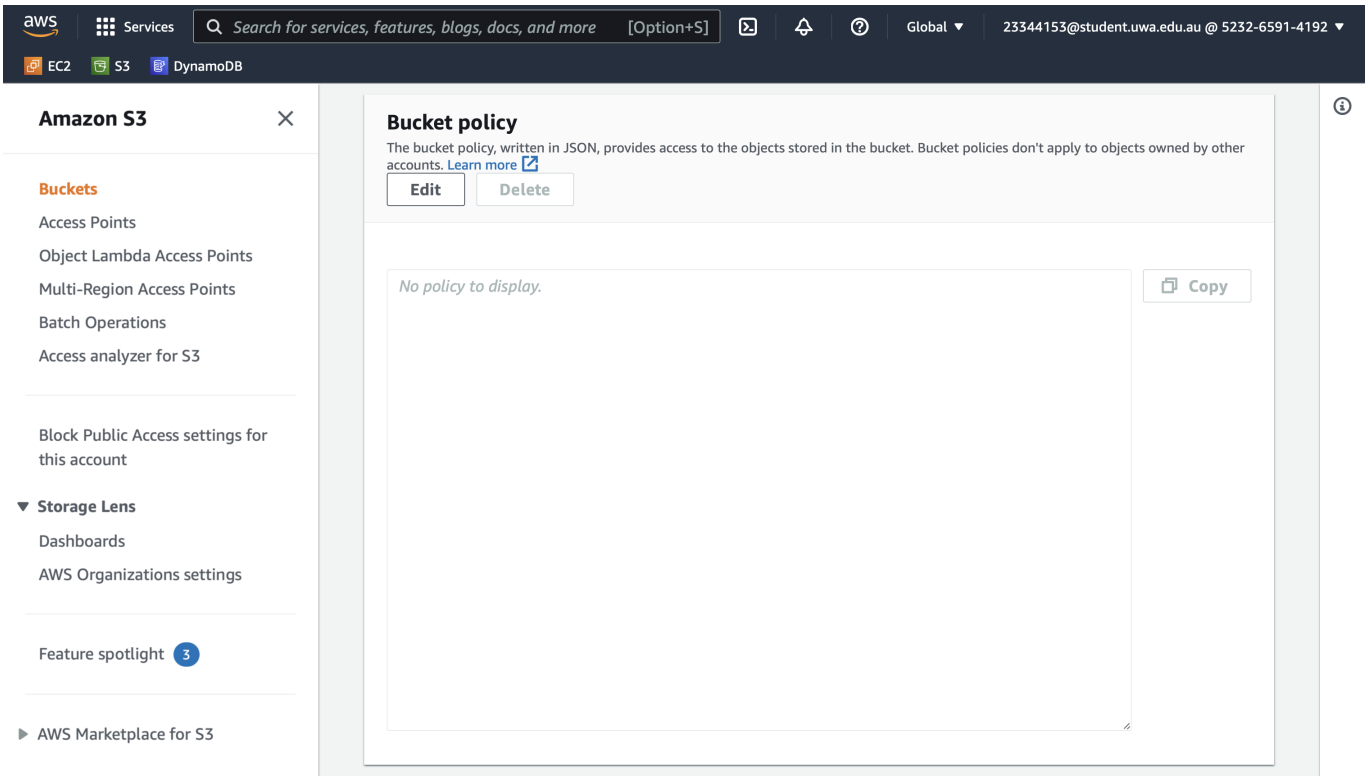
Practical Worksheet 4

Apply policy to restrict permissions on bucket



Before the bucket has no policy.

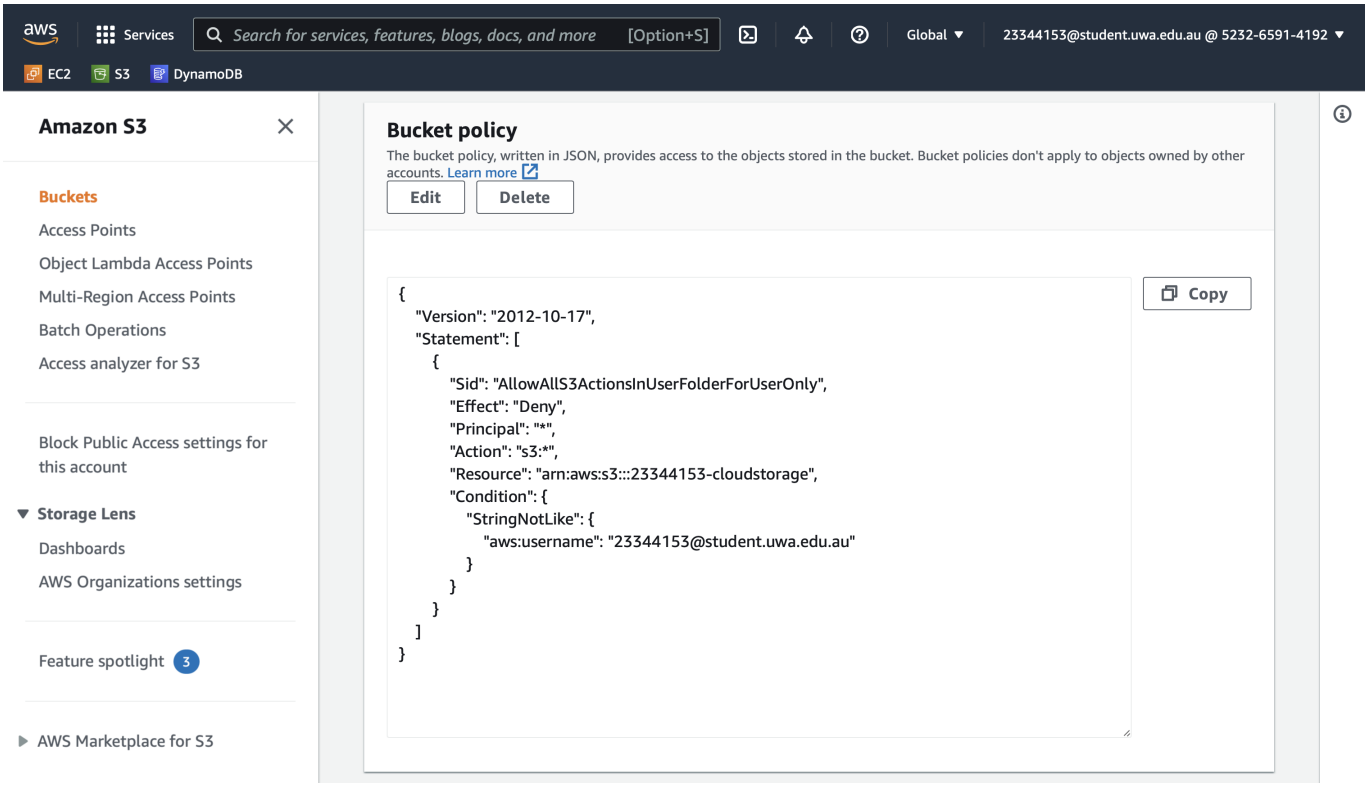
```
{
    "Version": "2012-10-17",
    "Statement": {
        "Sid": "AllowAllS3ActionsInUserFolderForUserOnly",
        "Effect": "DENY",
        "Principal": "*",
        "Action": "s3:*",
        "Resource": "arn:aws:s3:::23344153-cloudstorage",
        "Condition": {
            "StringNotLike": {
                "aws:username":"23344153@student.uwa.edu.au"
            }
        }
    }
}
```

```
'''apply_policy.py'''
import boto3
from lab4 import ROOT_S3_DIR
client = boto3.client('s3')
```

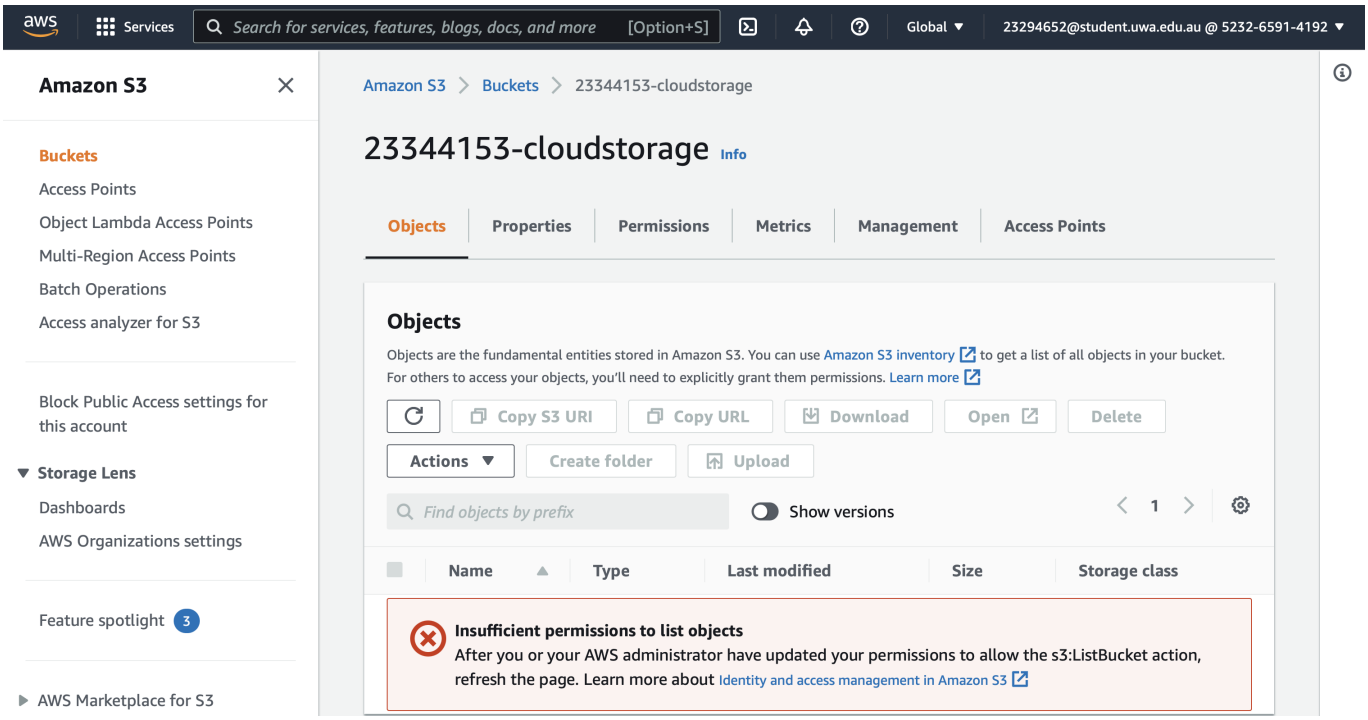
```
with open('policy.json', 'r') as policy:
    client.put_bucket_policy(
        Bucket=ROOT_S3_DIR,
        Policy=policy.read(),
    )
    print(client.get_bucket_policy(Bucket=ROOT_S3_DIR)['Policy'])
```

Run `apply_policy.py` to apply the policy in the `policy.json` file to the bucket.

```
(venv) >_ Labs/lab4 $ python apply_policy.py
{"Version":"2012-10-17","Statement":[{"Sid":"AllowAllS3ActionsInUserFolderForUserOnly","Effect":"Den
y","Principal":"*","Action":"s3:*","Resource":"arn:aws:s3:::23344153-cloudstorage","Condition":{"Str
ingNotLike":{"aws:username":"23344153@student.uwa.edu.au"}}}]}
```



The policy is now attached to the bucket and any other account that does not have the username `23344153@student.uwa.edu.au` has no permissions to view the bucket.



AES Encryption using KMS

```
{
    "Id": "key-consolepolicy-3",
    "Version": "2012-10-17",
    "Statement": [
        {
            "Sid": "Enable IAM User Permissions",
            "Effect": "Allow",
            "Principal": {
                "AWS": "arn:aws:iam::523265914192:root"
            },
            "Action": "kms:*",
            "Resource": "*"
        },
        {
            "Sid": "Allow access for Key Administrators",
            "Effect": "Allow",
            "Principal": {
                "AWS":
"arn:aws:iam::523265914192:user/23344153@student.uwa.edu.au"
            },
            "Action": [
                "kms:Create*",
                "kms:Describe*",
                "kms:Enable*",
                "kms:List*",
                "kms:Put*",
                "kms:Update*",
                "kms:Revoke*",
                "kms:Disable*",
                "kms:Get*",
```

```
                "kms:Delete*",
                "kms:TagResource",
                "kms:UntagResource",
                "kms:ScheduleKeyDeletion",
                "kms:CancelKeyDeletion"
            ],
            "Resource": "*"
        },
        {
            "Sid": "Allow use of the key",
            "Effect": "Allow",
            "Principal": {
                "AWS":
"arn:aws:iam::523265914192:user/23344153@student.uwa.edu.au"
            },
            "Action": [
                "kms:Encrypt",
                "kms:Decrypt",
                "kms:ReEncrypt*",
                "kms:GenerateDataKey*",
                "kms:DescribeKey"
            ],
            "Resource": "*"
        },
        {
            "Sid": "Allow attachment of persistent resources",
            "Effect": "Allow",
            "Principal": {
                "AWS":
"arn:aws:iam::523265914192:user/23344153@student.uwa.edu.au"
            },
            "Action": [
                "kms:CreateGrant",
                "kms:ListGrants",
                "kms:RevokeGrant"
            ],
            "Resource": "*",
            "Condition": {
                "Bool": {
                    "kms:GrantIsForAWSResource": "true"
                }
            }
        }
    ]
}
```

```
'''kms.py'''
import boto3
client = boto3.client('kms')

with open('key_policy.json', 'r') as policy:
```

```python
# create a key with a KMS policy
response = client.create_key(
    Policy=policy.read(),
)
key_id = response['KeyMetadata']['KeyId']
key_region = response['KeyMetadata']['Arn']
print(f'{key_id = }\n{key_region = }')

# add an alias
try:
    client.create_alias(
        AliasName='alias/23344153',
        TargetKeyId=key_id
    )
except:
    pass

# output the policy
print(client.get_key_policy(
    KeyId=key_id,
    PolicyName='default'
)['Policy'])

# generate a data key for encryption
data_key = client.generate_data_key(
    KeyId=key_id,
    KeySpec='AES_256'
)
data_key_encrypted = data_key['CiphertextBlob']
data_key = data_key['Plaintext']
print(f"{data_key_encrypted = }\n{data_key = }")
```

Run `kms.py`.

```
(venv) >_ Labs/lab4 $ python kms.py
key_id = '1d493282-5509-48db-9b6a-f3094b55e0cf'
key_region = 'arn:aws:kms:ap-southeast-2:523265914192:key/1d493282-5509-48db-9b6a-f3094b55e0cf'
{
  "Version" : "2012-10-17",
  "Id" : "key-consolepolicy-3",
  "Statement" : [ {
    "Sid" : "Enable IAM User Permissions",
    "Effect" : "Allow",
    "Principal" : {
      "AWS" : "arn:aws:iam::523265914192:root"
    },
    "Action" : "kms:*",
    "Resource" : "*"
  }, {
    "Sid" : "Allow access for Key Administrators",
    "Effect" : "Allow",
    "Principal" : {
      "AWS" : "arn:aws:iam::523265914192:user/23344153@student.uwa.edu.au"
    },
    "Action" : [ "kms:Create*", "kms:Describe*", "kms:Enable*", "kms:List*", "kms:Put*", "kms:Update
*", "kms:Revoke*", "kms:Disable*", "kms:Get*", "kms:Delete*", "kms:TagResource", "kms:UntagResource"
, "kms:ScheduleKeyDeletion", "kms:CancelKeyDeletion" ],
    "Resource" : "*"
  }, {
    "Sid" : "Allow use of the key",
    "Effect" : "Allow",
    "Principal" : {
      "AWS" : "arn:aws:iam::523265914192:user/23344153@student.uwa.edu.au"
    },
```

```
    "Action" : [ "kms:Encrypt", "kms:Decrypt", "kms:ReEncrypt*", "kms:GenerateDataKey*", "kms:Descri
beKey" ],
    "Resource" : "*"
  }, {
    "Sid" : "Allow attachment of persistent resources",
    "Effect" : "Allow",
    "Principal" : {
      "AWS" : "arn:aws:iam::523265914192:user/23344153@student.uwa.edu.au"
    },
    "Action" : [ "kms:CreateGrant", "kms:ListGrants", "kms:RevokeGrant" ],
    "Resource" : "*",
    "Condition" : {
      "Bool" : {
        "kms:GrantIsForAWSResource" : "true"
      }
    }
  } ]
}
data_key_encrypted = b'\x01\x02\x03\x00x\x94\r\x19 C\xbe\xde\xb0u|\xdb-\x1c\x8b\xec\xfe \x07F\x88mE\
xda?\x87\x94\x86<\x87Y1c\x01 (\xf4\xafW\x89Q\xd9\x19\xc2t\x95\x0cZ\xe1B\x00\x00\x00~0|\x06\t*\x86H\x
86\xf7\r\x01\x07\x06\xa0o0m\x02\x01\x000h\x06\t*\x86H\x86\xf7\r\x01\x07\x010\x1e\x06\t`\x86H\x01e\x0
3\x04\x01.0\x11\x04\x0c\xfeB#\xe23\x117\xcd\xf2\x7frg\x02\x01\x10\x80;V\xed\x8f\xb5\xd5==W.\xb0\xe1\
xb1\x9ek\x8fq\xd8h\xdcqp\xb9r\xbd\xc0w\x9fr\xa5"B\xe4B\xe6\xf0b(+Z\xe30@E\xfb\x1e\xab\xec\xbd\x82;Go
\xc3\x86\x92\x8an?A'
data_key = b'n\x87\x95\xb1k\xc3/\xdb\xa2\xc2z\x10\xe3\x11\xc8|N\xd8+\x80\x11\xb1\xef)1\xa4\xba\xc2\x
f8]\\\xd4'
```

```python
'''
lab4.py

Sample application to encrypt and decrypt files using AES
'''
import os, struct
from Crypto.Cipher import AES
from Crypto import Random
import hashlib

ROOT_S3_DIR = '23344153-cloudstorage'
CHUNK_SIZE = 64 * 1024
```

```python
def encrypt_file(key, file):

    iv = Random.new().read(AES.block_size)
    encryptor = AES.new(key, AES.MODE_CBC, iv)
    filesize = os.path.getsize(file)

    with open(file, 'rb') as infile:
        with open(f'{file}.enc', 'wb') as outfile:
            outfile.write(struct.pack('<Q', filesize))
            outfile.write(iv)

            while True:
                chunk = infile.read(CHUNK_SIZE)
                if len(chunk) == 0:
                    break
                elif len(chunk) % 16 != 0:
                    chunk += ' '.encode("utf-8") * (16 - len(chunk) % 16)

                outfile.write(encryptor.encrypt(chunk))

def decrypt_file(key, file):

    with open(file, 'rb') as infile:
        origsize = struct.unpack('<Q', infile.read(struct.calcsize('Q')))
[0]
        iv = infile.read(16)
        decryptor = AES.new(key, AES.MODE_CBC, iv)

        with open(f'{file}.dec', 'wb') as outfile:
            while True:
                chunk = infile.read(CHUNK_SIZE)
                if len(chunk) == 0:
                    break
                outfile.write(decryptor.decrypt(chunk))

            outfile.truncate(origsize)

password = 'password'
key = hashlib.sha256(password.encode("utf-8")).digest()
if __name__ == '__main__':
    encrypt_file(key, "test.txt")
    decrypt_file(key, "test.txt.enc")
```

```python
'''
cloudstorage.py

Skeleton application to copy local files to S3

Given a root local directory, will return files in each level and
copy to same path on S3
'''
```

```python
import os
import sys
import boto3
import base64
from lab4 import ROOT_S3_DIR, key, encrypt_file

client = boto3.client('s3')
s3 = boto3.resource('s3')

# create bucket if not there
argv = sys.argv[1:]
if len(argv) > 0 and '-i' in argv:
    try:
        response = client.create_bucket(
            Bucket=ROOT_S3_DIR,
            CreateBucketConfiguration={
                'LocationConstraint': 'ap-southeast-2'
            },
        )
        print(response)
    except Exception as error:
        print(error)

def upload_file(file):
    out_filename = f'{file}.enc'
    if '-k' in argv:
        # KMS
        from kms import data_key, data_key_encrypted
        encrypt_file(data_key, file)
        client.put_object(
            Body=open(out_filename, 'rb'),
            Bucket=ROOT_S3_DIR,
            # enable SSE-KMS
            ServerSideEncryption='aws:kms',
            Key=file,
            # put encrypted data key in the metadata so the data key can
            # be obtained by decrypting the encrypted data key
            Metadata={
                'encryption-key':
base64.b64encode(data_key_encrypted).decode()
            }
        )
        print("Uploading %s" % out_filename)
    elif '-c' in argv:
        # using a hash key to encrypt
        encrypt_file(key, file)
        s3.meta.client.upload_file(out_filename, ROOT_S3_DIR, file)
        print("Uploading %s" % out_filename)
    else:
        # upload files unencrypted
        s3.meta.client.upload_file(file, ROOT_S3_DIR, file)
        print("Uploading %s" % file)

# parse the current directory and upload all the text files
```

```
for dir_name, subdir_list, file_list in os.walk('.', topdown=True):
    for fname in file_list:
        # only upload files with a txt extension
        if fname.endswith('.txt'):
            upload_file(f'{dir_name}/{fname}')

print("done")
```

```
'''restorefromcloud.py'''
import os
import sys
import boto3
import base64
from lab4 import ROOT_S3_DIR, key, decrypt_file

client = boto3.client('s3')
s3 = boto3.resource('s3')
kms = boto3.client('kms')

argv = sys.argv[1:]
for content in client.list_objects(Bucket=ROOT_S3_DIR)['Contents']:
    paths = content['Key'].split('/')
    file = paths[-1]
    # create the directories listed in the path
    for dir in paths[:-1]:
        if not os.path.isdir(dir):
            os.mkdir(dir)
        os.chdir(dir)
    # download the file from S3 to the deepest directory
    s3.meta.client.download_file(ROOT_S3_DIR, content['Key'], file)

    if len(argv) == 1:
        # using KMS data key to decrypt
        if argv[0] in ['-k', '--kms=True']:
            key = client.get_object(
                Bucket=ROOT_S3_DIR,
                Key=content['Key']
            )['Metadata']['encryption-key']
            # decrypt the encrypted data key from the meta data first
            decrypt_file(
                kms.decrypt(CiphertextBlob=base64.b64decode(key))
['Plaintext'],
                file
            )
        # using a hash key to decrypt
        elif argv[0] in ['-c', '--crypto=True']:
            decrypt_file(key, file)

    # go back to the root directory
    for i in range(len(paths) - 1):
        os.chdir('..')
```

Run `cloudstorage.py` to upload the file that has been encrypted locally to `S3`.

Run `restorefromcloud.py` to download the encrypted file and decrypt it locally to view the original content.

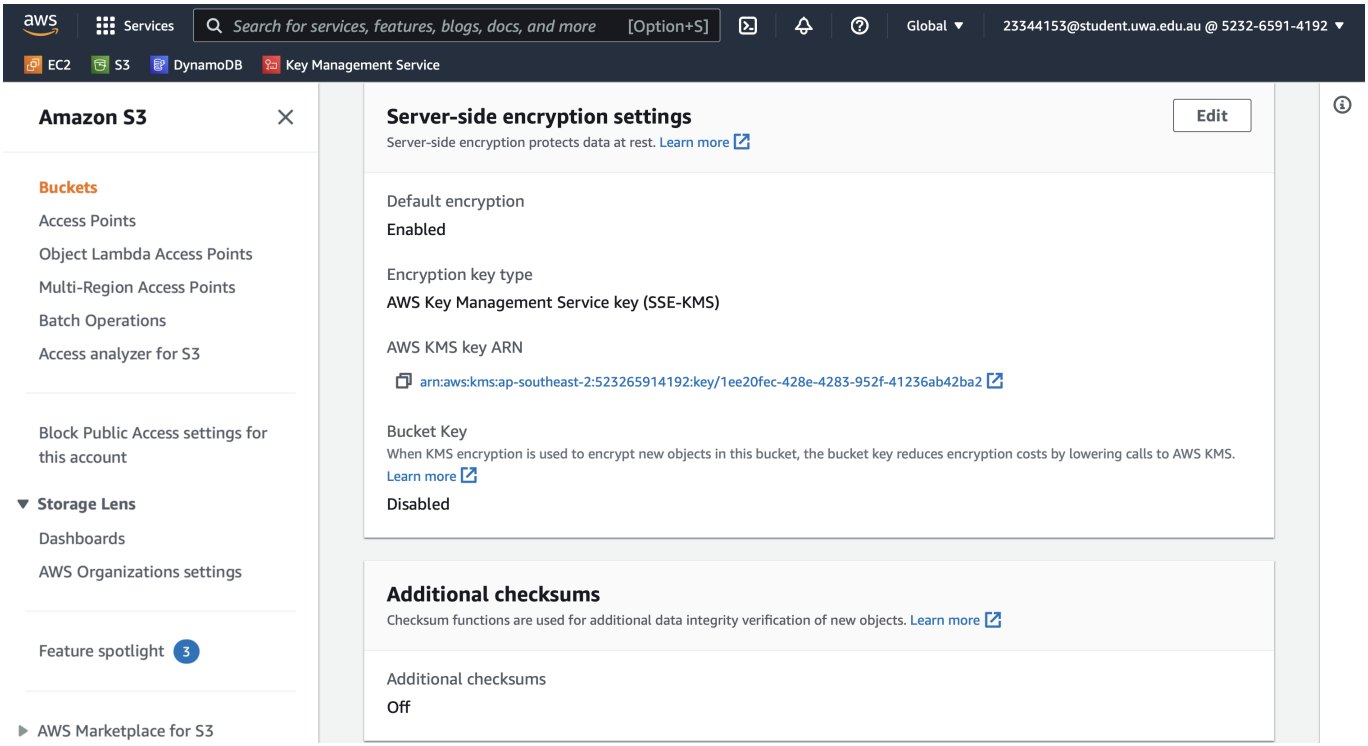
With the `-k` flag it uses the data key generated from the `KMS customer managed key` created earlier for encryption and also adds Server-side encryption.

```
(venv) >_ Labs/lab4 $ cat test.txt
hello world
(venv) >_ Labs/lab4 $ python cloudstorage.py -k
Uploading ./test.txt.enc
done
(venv) >_ Labs/lab4 $ cat test.txt.enc

>??T.???Bh??
            ?N??A#)??Y??ZR? E%
(venv) >_ Labs/lab4 $ rm test.txt*
(venv) >_ Labs/lab4 $ python restorefromcloud.py -k
(venv) >_ Labs/lab4 $ cat test.txt

>??T.???Bh??
            ?N??A#)??Y??ZR? E%
(venv) >_ Labs/lab4 $ cat test.txt.dec
hello world
```

Server-side encryption is set to `SSE-KMS`.



AES Encryption using local python library pycryptodome

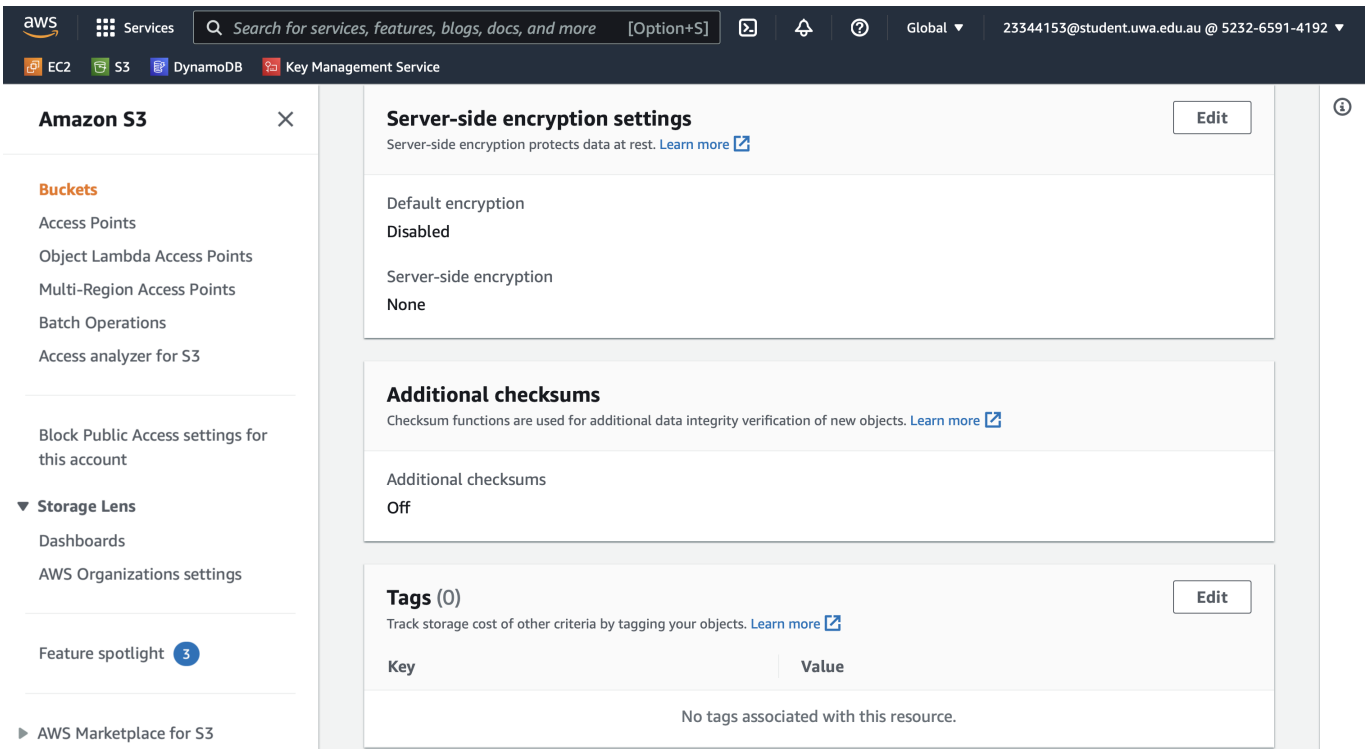
Run `cloudstorage.py` and `restorefromcloud.py` with the `-c` flag to use a custom hash as the symmetric key for encryption and decryption.

```
(venv) >_ Labs/lab4 $ cat test.txt
hello world
(venv) >_ Labs/lab4 $ python cloudstorage.py -c
Uploading ./test.txt.enc
done
(venv) >_ Labs/lab4 $ cat test.txt.enc

???M"2[W????#mA?Eq6oS}x?)uZ"%
(venv) >_ Labs/lab4 $ rm test.txt*
(venv) >_ Labs/lab4 $ python restorefromcloud.py -c
(venv) >_ Labs/lab4 $ cat test.txt

???M"2[W????#mA?Eq6oS}x?)uZ"%
(venv) >_ Labs/lab4 $ cat test.txt.dec
hello world
```

Server-side encryption is disabled.



What is the performance difference between using KMS and using the custom solution?

```
(venv) >_ Labs/lab4 $ time python cloudstorage.py -k
Uploading ./rootdir/rootfile.txt.enc
Uploading ./rootdir/subdir/subfile.txt.enc
done
python3 cloudstorage.py -k  0.40s user 0.10s system 8% cpu 5.956 total
(venv) >_ Labs/lab4 $ time python cloudstorage.py -c
Uploading ./rootdir/rootfile.txt.enc
Uploading ./rootdir/subdir/subfile.txt.enc
done
python3 cloudstorage.py -c  0.42s user 0.11s system 9% cpu 5.694 total
```

I constructed a slightly larger file structure to compare the performance of the different approaches to encryption. The result is using KMS for encryption and SSE-KMS is slightly slower than the custom solution. However I would still use KMS because there are separate permissions for the use of a KMS key which provides added protection against unauthorised access to objects in S3 and SSE-KMS also provides an audit trail that shows when the KMS key was used and by whom.