Cosmos DB Labs for Python Programmers
Lab 1 Cosmos DB Databases and Collections

In this lab, you will create multiple Azure Cosmos DB containers. Some of the containers will be unlimited and configured with a partition key, while others will be fixed-sized. You will then use the SQL API and .NET SDK to query specific containers using a single partition key or across multiple partition keys.

Exercise 1 Log-in to the Azure Portal

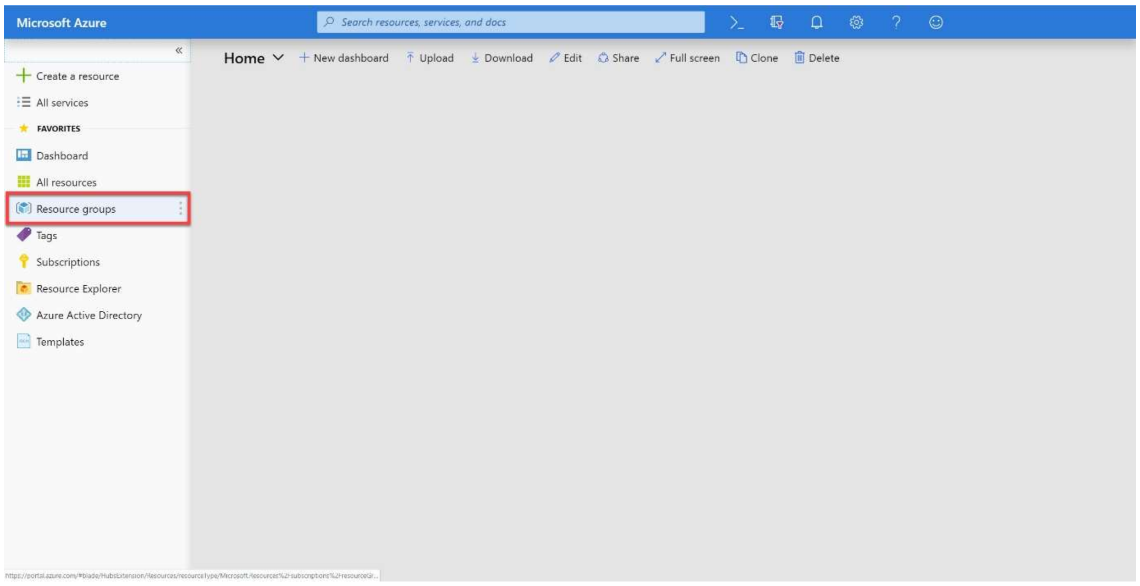
1. In a new window, sign in to the Azure Portal (http://portal.azure.com).
2. Once you have logged in, you may be prompted to start a tour of the Azure portal. You can safely skip this step.

Exercise 2 Azure Cosmos DB Setup

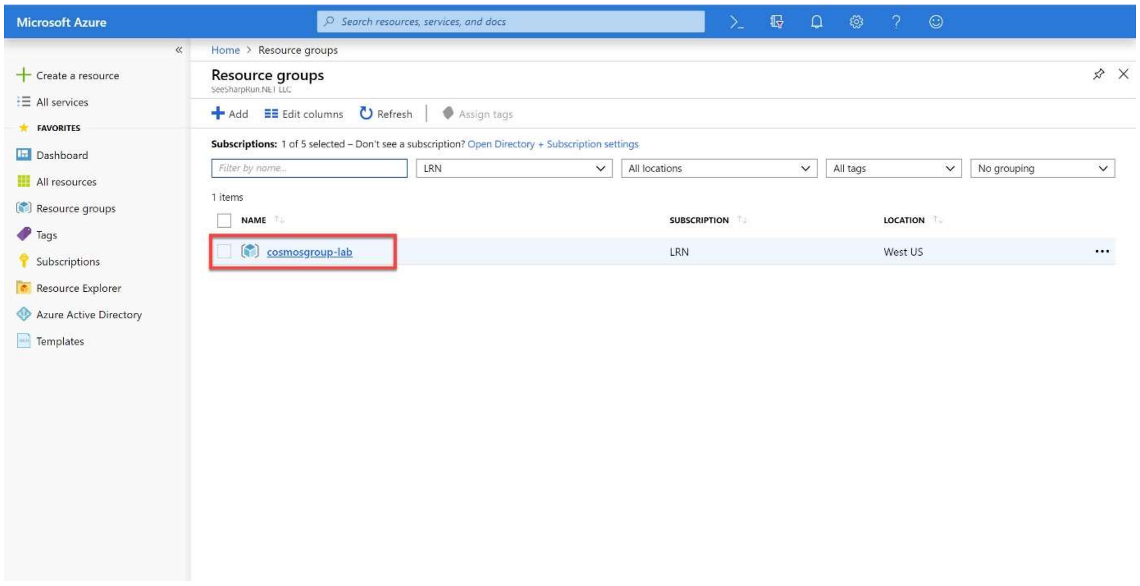
Before you start this lab, you will need to create an Azure Cosmos DB database and collection that you will use throughout the lab. The Python SDK requires credentials to connect to your Azure Cosmos DB account. You will collect and store these credentials for use throughout the lab.

Retrieve Account Credentials

1. On the left side of the portal, click the Resource groups link.



2. In the Resource groups blade, locate and select the cosmosgroup-lab *Resource Group*.

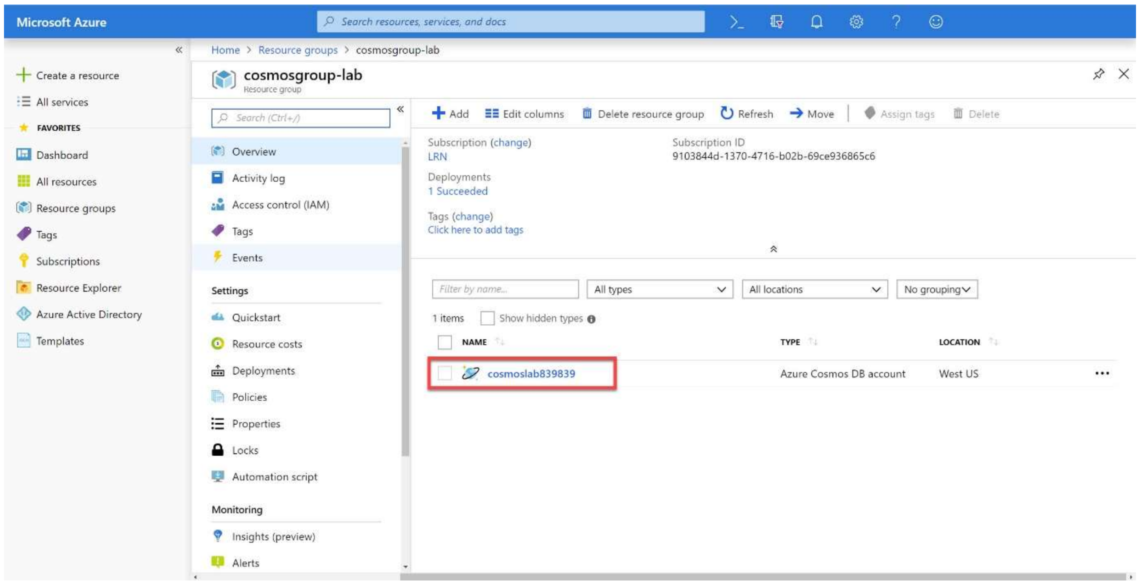


Subscriptions: 1 of 5 selected – Don't see a subscription? Open Directory + Subscription settings

1 items

NAME	SUBSCRIPTION	LOCATION
cosmosgroup-lab	LRN	West US

3. In the cosmosgroup-lab blade, select the Azure Cosmos DB account you recently created.



Subscription (change)
LRN

Subscription ID
9103844d-1370-4716-b02b-69ce936865c6

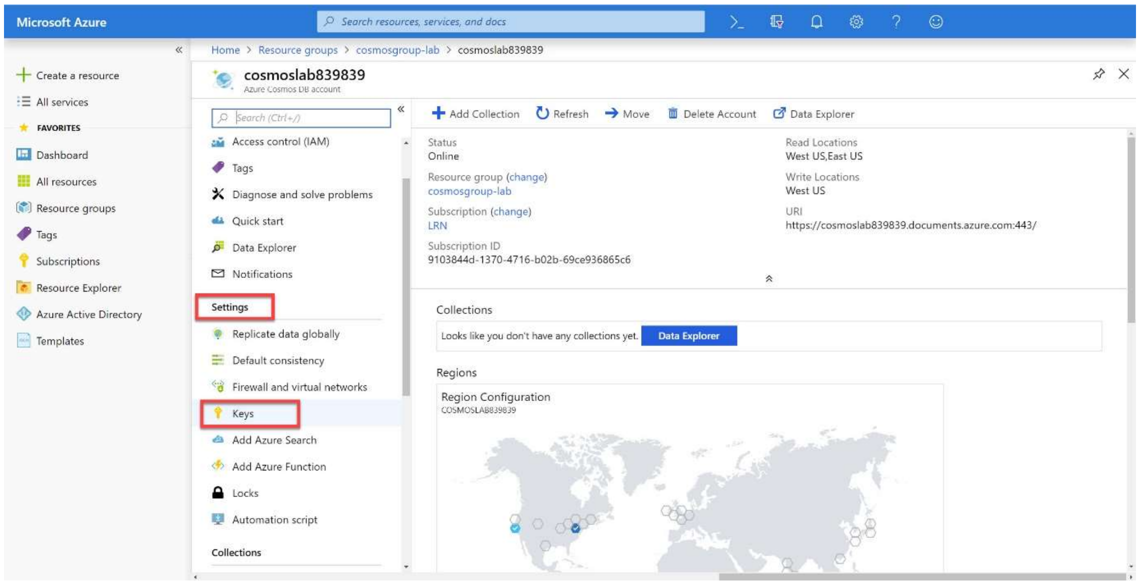
Deployments
1 Succeeded

Tags (change)
Click here to add tags

1 items

NAME	TYPE	LOCATION
cosmoslab839839	Azure Cosmos DB account	West US

4. In the Azure Cosmos DB blade, locate the Settings section and click the Keys link.



Status
Online

Resource group (change)
cosmosgroup-lab

Subscription (change)
LRN

Subscription ID
9103844d-1370-4716-b02b-69ce936865c6

Read Locations
West US,East US

Write Locations
West US

URI
https://cosmoslab839839.documents.azure.com:443/

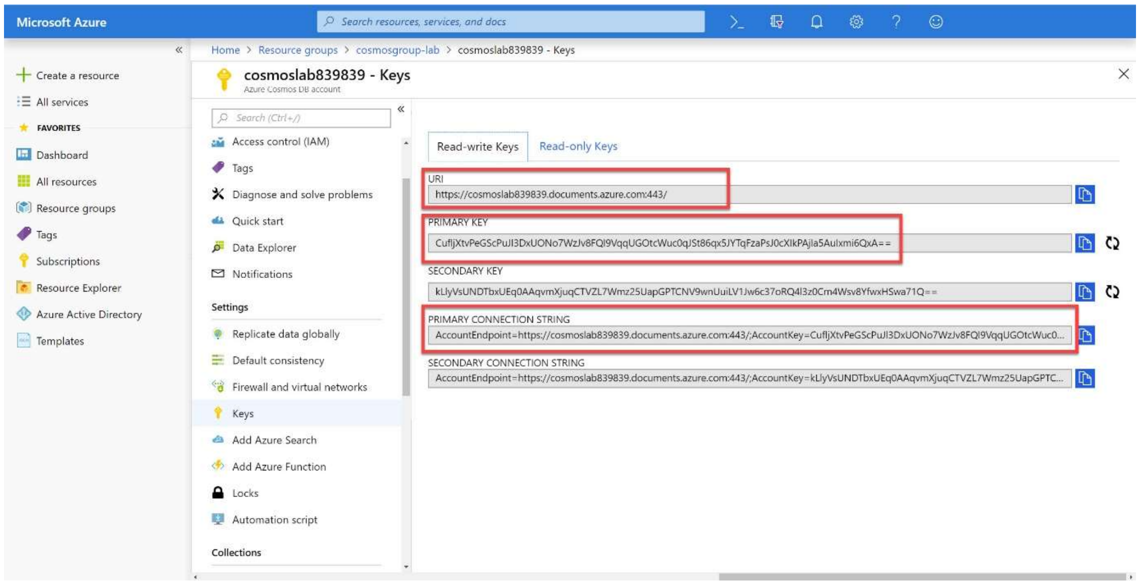
Collections

Looks like you don't have any collections yet.

Regions

Region Configuration
COSMOSLAB839839

5. In the Keys pane, record the values in the CONNECTION STRING, URI and PRIMARY KEY fields. You will use these values later in this lab.



URI
https://cosmoslab839839.documents.azure.com:443/

PRIMARY KEY
CufljXtvPeGScPuJl3DxUONo7WzJv8FQl9VqqUGOtcWuc0qJSt86qx5JYTqFzaPsJ0cXlkPAjla5Aulxmi6QxA==

SECONDARY KEY
kLlyVsUNDTbxUEq0AAqvmXjuqCTVZL7Wmz25UapGPTCNV9wnUuiLV1Jw6c37oRQ4l3z0Cm4Wsv8YfwxHSwa71Q==

PRIMARY CONNECTION STRING
AccountEndpoint=https://cosmoslab839839.documents.azure.com:443/;AccountKey=CufljXtvPeGScPuJl3DxUONo7WzJv8FQl9VqqUGOtcWuc0...

SECONDARY CONNECTION STRING
AccountEndpoint=https://cosmoslab839839.documents.azure.com:443/;AccountKey=kLlyVsUNDTbxUEq0AAqvmXjuqCTVZL7Wmz25UapGPTC...

Exercise 3 Create Containers using the Python SDK

Task I Setup the Python environment

Install python 3.6 on your Windows PC

Create a directory to house your project
Open a command window in the new directory

In the command wind run virtualenv to create a python environment to install the required python modules in

It is possible you may have to install virtualenv with
```
> pip install virtualenv
```

```
D:\src\PythonProjects\CosmosLabs>virtualenv pyenv3

Activate the environment:

D:\src\PythonProjects\CosmosLabs>pyenv3\Scripts\activate

(pyenv3) D:\src\PythonProjects\CosmosLabs>
```

You will notice the name of the environment in brackets at the command prompt
Install the required Cosmos DB libraries

```
(pyenv3) D:\src\PythonProjects\CosmosLabs> pip install azure-cosmos
Collecting azure-cosmos
…
Successfully installed azure-cosmos-3.0.2…


(pyenv3) D:\src\PythonProjects\CosmosLabs>pip install azure-mgmt-cosmosdb
Collecting azure-mgmt-cosmosdb
…
…
```

Install a library to generate test data

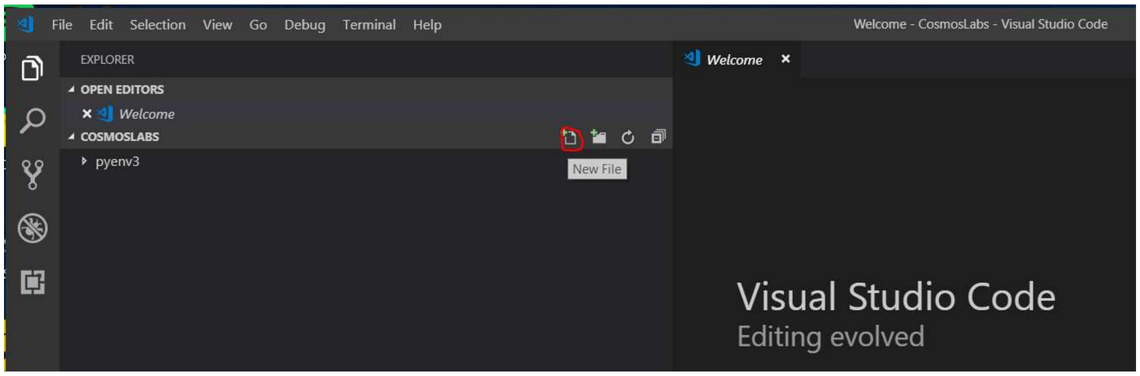
```
(pyenv3) D:\src\PythonProjects\CosmosLabs>pip install faker
Collecting faker
…
…
```

Task II Creating a Database Client Connection

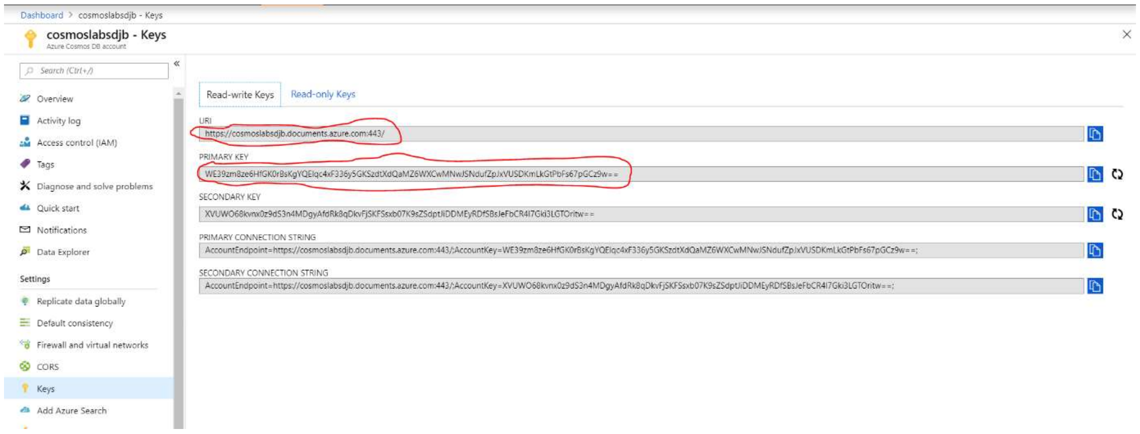
Open the project directory with Visual Studio Code (VSC)

```
(pyenv3) D:\src\PythonProjects\CosmosLabs>code .
```

Create a simple config.json file to store the Cosmos DB account credentials in
Remember to put config.json in your .gitignore file if you are using git source control



Grab the endpoint and the keys for your config.json file



URI
https://cosmoslabsdjb.documents.azure.com:443/

PRIMARY KEY
WE39zm8ze6HfGK0rBsKgYQElqc4xF336y5GKSzdtXdQaMZ6WXCwMNwJSNdufZpJxVUSDKmLkGtPbFs67pGCz9w==

SECONDARY KEY
XVUWO68kvnx0z9dS3n4MDgyAfdRk8qDkvFjSKFSsxb07K9sZSdptJiDDMEyRDfSBsJeFbCR4I7Gki3LGTOritw==

PRIMARY CONNECTION STRING
AccountEndpoint=https://cosmoslabsdjb.documents.azure.com:443/;AccountKey=WE39zm8ze6HfGK0rBsKgYQElqc4xF336y5GKSzdtXdQaMZ6WXCwMNwJSNdufZpJxVUSDKmLkGtPbFs67pGCz9w==;

SECONDARY CONNECTION STRING
AccountEndpoint=https://cosmoslabsdjb.documents.azure.com:443/;AccountKey=XVUWO68kvnx0z9dS3n4MDgyAfdRk8qDkvFjSKFSsxb07K9sZSdptJiDDMEyRDfSBsJeFbCR4I7Gki3LGTOritw==;

Put your values from the portal in the config.json file in VSC and save them

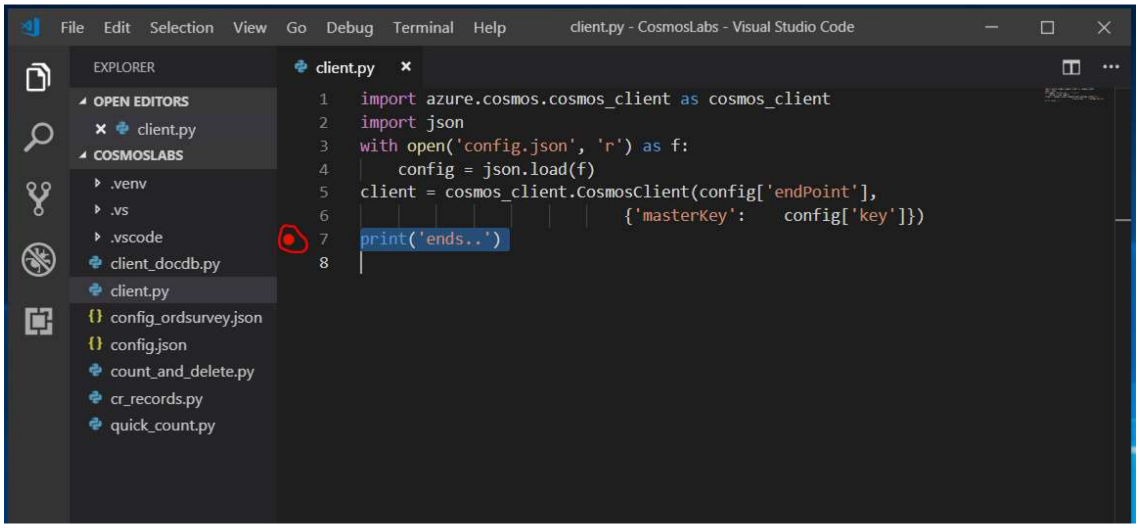
```json
{
    "endPoint": "https://cosmoslabsdjb.documents.azure.com:443/",
    "key": "AZ3fh8Znkkgdf8shf7fHHJJ7r49BGSOEUIEJHE354mjb54WAfd48f7sd8A847BSGS8ujMiydh98nWomd9FGx0r=="
}
```

Create a new file called client.py and we will create a database client using the configuration and verify connection.

Copy and paste the following code

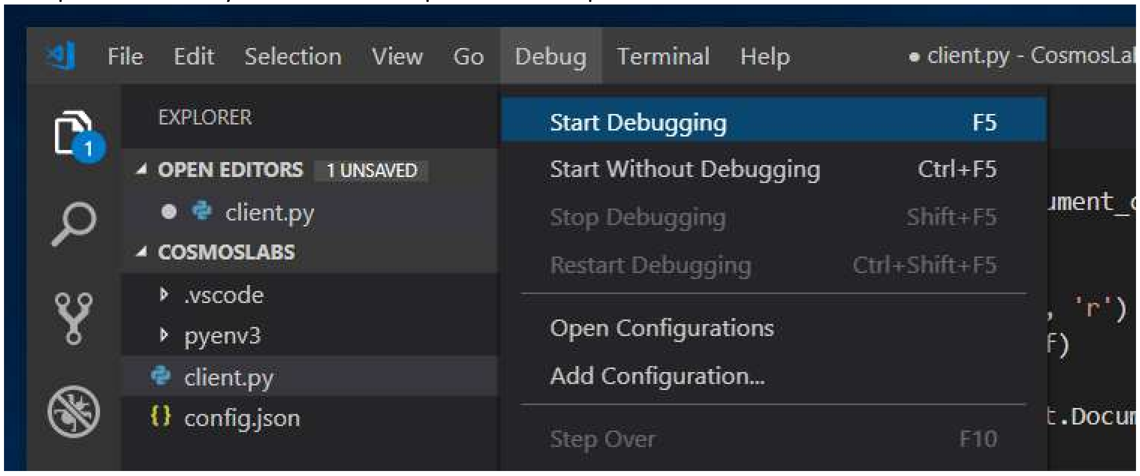
```python
import azure.cosmos.cosmos_client as cosmos_client
import json
with open('config.json', 'r') as f:
    config = json.load(f)
client = cosmos_client.CosmosClient(config['endPoint'],
                            {'masterKey':    config['key']})
print('ends..')
```

In the code window for the client.py script click in the left hand margin and a red dot will appear. This will set a breakpoint for the python debugger integrated with Visual Studio Code.

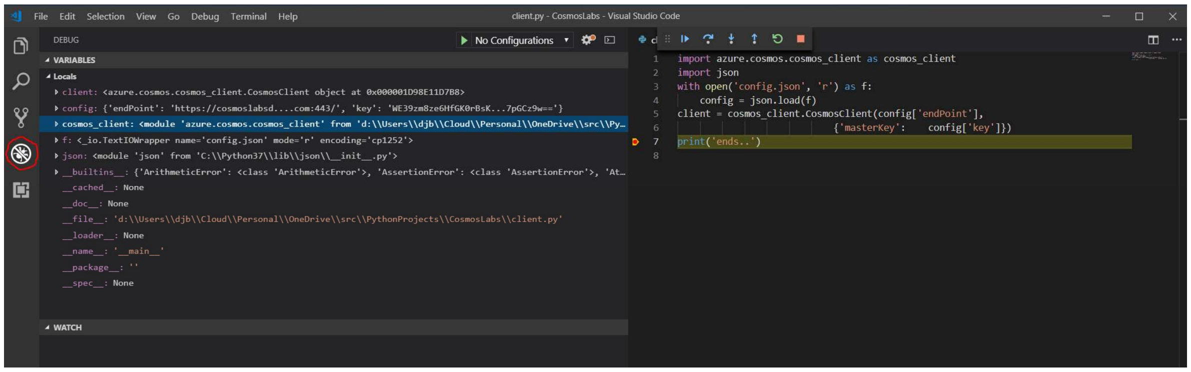


```python
import azure.cosmos.cosmos_client as cosmos_client
import json
with open('config.json', 'r') as f:
    config = json.load(f)
client = cosmos_client.CosmosClient(config['endPoint'],
                            {'masterKey':    config['key']})
print('ends..')
```

Select Debug > Start Debugging from the menu or press F5 to begin debugging. The python interpreter will run your code and stop at the break point



The interpreter will stop at the breakpoint and the debug context should be selected for the left hand panel of Visual Studio Code (VSC).


File Edit Selection View Go Debug Terminal Help
client.py - CosmosLabs - Visual Studio Code
DEBUG
No Configurations
VARIABLES
Locals
WATCH

```
client: <azure.cosmos.cosmos_client.CosmosClient object at 0x000001D98E11D7B8>
config: {'endPoint': 'https://cosmoslabsd....com:443/', 'key': 'WE39zm8ze6HfGK0rBsK...7pGCz9w=='}
cosmos_client: <module 'azure.cosmos.cosmos_client' from 'd:\\Users\\djb\\Cloud\\Personal\\OneDrive\\src\\Py…
f: <_io.TextIOWrapper name='config.json' mode='r' encoding='cp1252'>
json: <module 'json' from 'C:\\Python37\\lib\\json\\__init__.py'>
__builtins__: {'ArithmeticError': <class 'ArithmeticError'>, 'AssertionError': <class 'AssertionError'>, 'At…
__cached__: None
__doc__: None
__file__: 'd:\\Users\\djb\\Cloud\\Personal\\OneDrive\\src\\PythonProjects\\CosmosLabs\\client.py'
__loader__: None
__name__: '__main__'
__package__: ''
__spec__: None
```

```python
import azure.cosmos.cosmos_client as cosmos_client
import json
with open('config.json', 'r') as f:
    config = json.load(f)
client = cosmos_client.CosmosClient(config['endPoint'],
                                    {'masterKey':    config['key']})
print('ends..')
```

Press the Continue icon above the code at the top of the right panel to finish the script and exit

---

Task III Create a Database using the Python SDK

In the client.py script add the following line below the client definition in the script.

```python
db = client.CreateDatabase({ 'id': 'EntertainmentDatabase'} )
```

Add a line following to print out the database resource link for the newly created database

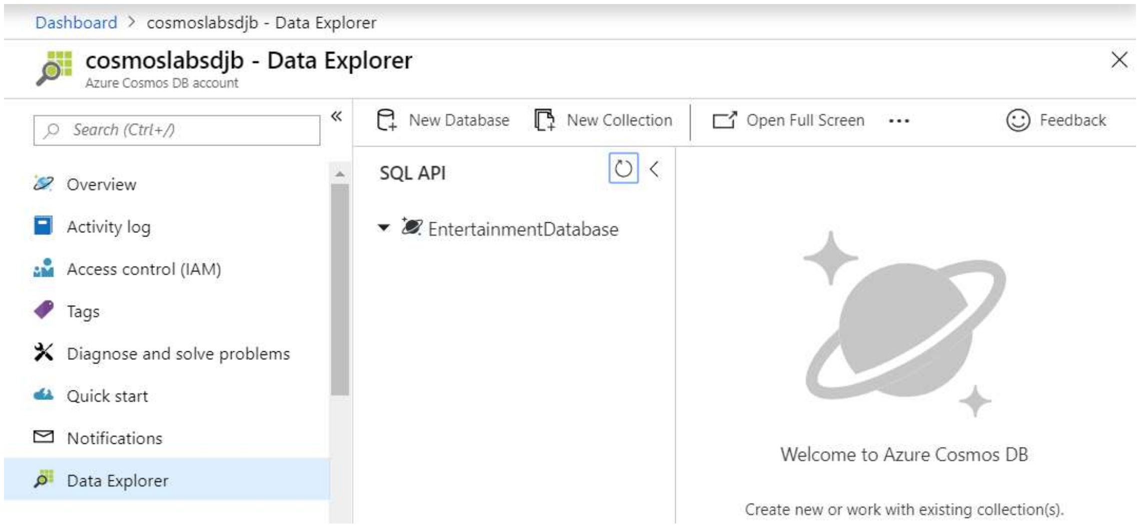
```python
print('Database self link is: {}'.format(db['_self']))
```

Your code should look like the following :

```python
import azure.cosmos.cosmos_client as cosmos_client
import json
with open('config.json', 'r') as f:
    config = json.load(f)
client = cosmos_client.CosmosClient(config['endPoint'],
                                    {'masterKey':    config['key']})

db = client.CreateDatabase({ 'id': 'EntertainmentDatabase'} )
print('Database self link is: {}'.format(db['_self']))


print('ends..')
```

Run the code by pressing F5 in Visual Studio Code and verify that a database link is emitted at the Terminal window, below the source pane on the right.

Look in the Azure portal to verify that the database has been created. Select the "Data Explorer" tab from the main page of the Cosmos DB Account you created earlier.



Run the script again and verify it fails on the client.CreateDatabase as there is already a database with the id EntertainmentDatabase created.

Have a look at the contents of the db variable in the debugger window.

Tidy up the database creation code so that we catch the exception if a database with the chosen name already exists and read the link for the existing database with the following code:

```python
import azure.cosmos as cosmos
import azure.cosmos.cosmos_client as cosmos_client
import json
with open('config.json', 'r') as f:
    config = json.load(f)
client = cosmos_client.CosmosClient(config['endPoint'],
                            {'masterKey':    config['key']})

databaseID = 'EntertainmentDatabase'
try:
    db = client.CreateDatabase({ 'id': databaseID} )
except Exception as ex:
    if type(ex) == cosmos.errors.HTTPFailure and ex.status_code == 409:
        # database already exists
        db = client.ReadDatabase('dbs/' + databaseID )
    else:
        print("we had a problem")
        raise ex

print('Database self link is: {}'.format(db['_self']))

print('ends..')
```

Rename the python source file to createDatabase.py and save it.

Task IV Create a Fixed size collection using the Python SDK

Azure Cosmos DB containers can be created as fixed or unlimited in Python SDK. You can create unlimited sized collections in the Azure portal, but you can no longer created fixed size collections. Fixed-size containers have a maximum limit of 10 GB and 10,000 RU/s throughput. Throughput is the rate at which the database takes in and processes data. A request unit is a normalized quantity that represents the amount of computation required to serve a request. In Cosmos DB, you reserve a guaranteed amount of throughput on a collection or across the database, measured in RU/s. To learn more, refer to /docs.microsoft.com/azure/cosmos-db/request-units. You will create a fixed-size container in this task.

Add the following code to a new python source file named createFixedColl.py to create an options dictionary that is used to then create the fixed size collection in the existing database. In the definition for the collection we simply pass a directory object in with a single id : value attribute.
We can then create the collection in the try: block
Set breakpoints as shown before (hint: click to the right of the code until a red dot appears) and examine the values for collection and db objects.

```python
import azure.cosmos as cosmos
import azure.cosmos.cosmos_client as cosmos_client
import json

with open('config.json', 'r') as f:
    config = json.load(f)

client = cosmos_client.CosmosClient(config['endPoint'],{'masterKey':
config['key']})
databaseID = 'EntertainmentDatabase'
collectionID = 'DefaultCollection'

try:
    db = client.CreateDatabase({ 'id': databaseID} )
except Exception as ex:
    if type(ex) == cosmos.errors.HTTPFailure and ex.status_code == 409:
        # database already exists
        db = client.ReadDatabase('dbs/' + databaseID )
    else:
        print("we had a problem creating database")
        raise ex

print('Database self link is: {}'.format(db['_self']))

options = {
                'offerEnableRUPerMinuteThroughput': True,
                'offerVersion': "V2",
                'offerThroughput': 400
}

try:
    collection = client.CreateContainer(db['_self'], { 'id': collectionID },
options)
except Exception as ex:
    if type(ex) == cosmos.errors.HTTPFailure and ex.status_code == 409:
        # collection already exists
        collection = client.ReadContainer('dbs/' + databaseID + '/colls/' +
collectionID )
    else:
        print("we had a problem creating collection")
        raise ex

print('Collection self link for {} is: {}'.format(collectionID,
collection['_self']))
print('\nends..')
```

createFixedColl.py

Examine the DefaultCollection you have created in the Azure portal - data explorer. Look at the values in EntertainmentDatabase > DefaultCollection > Scale & Settings. Notice the storage Capacity is Fixed - limited to 10GB maximum.

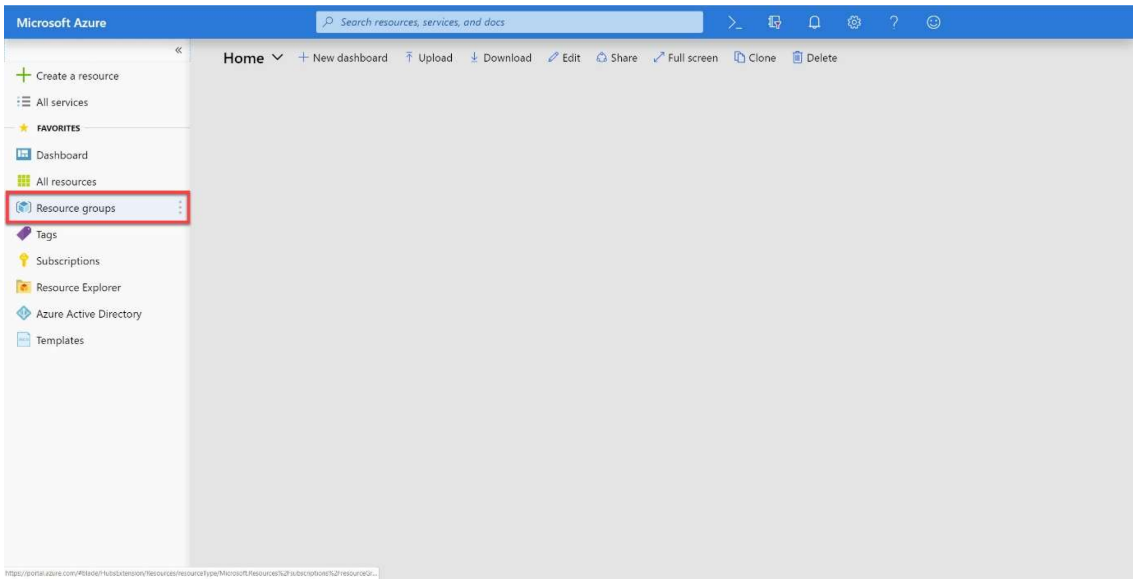
Task V Create an Unlimited size collection using the Python SDK

In order to create an unlimited collection we pass a dictionary object with specifiers for the id and the partition key for the collection to the Client.CreateContainer method. Create a new file called CreateUnlimColl.py and add the following code to it.

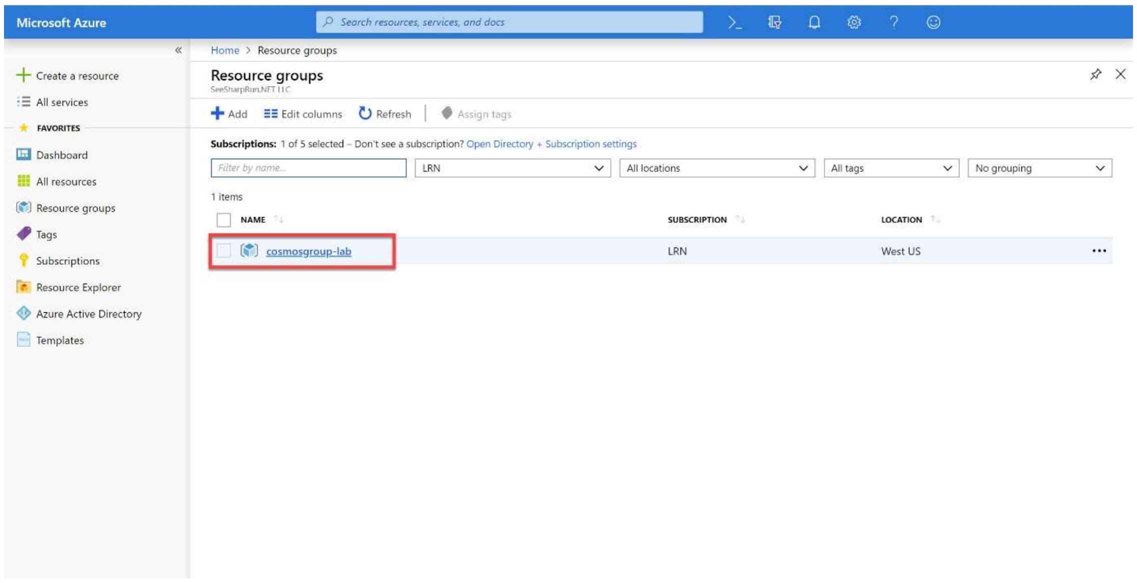
```python
import azure.cosmos as cosmos
import azure.cosmos.cosmos_client as cosmos_client
import json

with open('config.json', 'r') as f:
    config = json.load(f)

client = cosmos_client.CosmosClient(config['endPoint'],{'masterKey':
config['key']})
databaseID = 'EntertainmentDatabase'
collectionID = 'CustomCollection'

try:
    db = client.CreateDatabase({ 'id': databaseID} )
except Exception as ex:
    if type(ex) == cosmos.errors.HTTPFailure and ex.status_code == 409:
        # database already exists
        db = client.ReadDatabase('dbs/' + databaseID )
    else:
        print("we had a problem creating database")
        raise ex

print('Database self link is: {}'.format(db['_self']))

coll = {
            "id": collectionID,
            "partitionKey": {
                                "paths": ["/AccountNumber"],
                                "kind": "Hash"
                            }
 }

options = {
                'offerEnableRUPerMinuteThroughput': True,
                'offerVersion': "V2",
                'offerThroughput': 400
}

try:
    collection = client.CreateContainer(db['_self'], coll, options)
except Exception as ex:
    if type(ex) == cosmos.errors.HTTPFailure and ex.status_code == 409:
        # collection already exists
        collection = client.ReadContainer('dbs/' + databaseID + '/colls/' +
collectionID )
    else:
        print("we had a problem creating collection")
        raise ex

print('Collection self link for {} is: {}'.format(collectionID,
collection['_self']))
print('\nends..')
```

Task VI Observe Newly Created Database and Collections in the Portal

1. In a new window, sign in to the Azure Portal (http://portal.azure.com).
2. On the left side of the portal, click the Resource groups link.



3. In the Resource groups blade, locate and select the cosmosgroup-lab *Resource Group*.



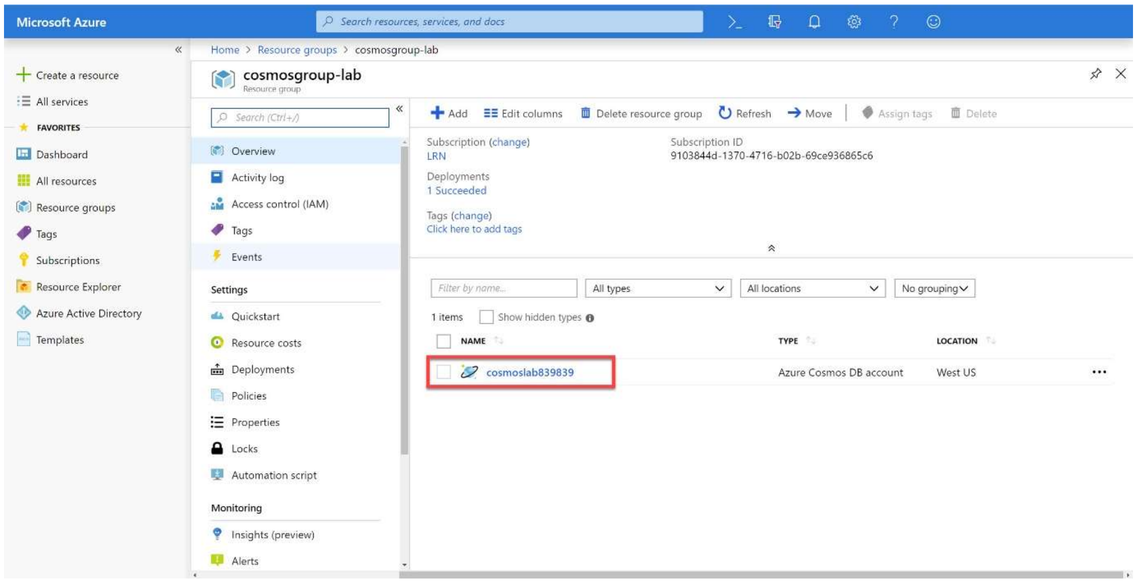
Subscriptions: 1 of 5 selected – Don't see a subscription? Open Directory + Subscription settings

Filter by name... | LRN | All locations | All tags | No grouping

1 items

NAME	SUBSCRIPTION	LOCATION
cosmosgroup-lab	LRN	West US

4. In the **cosmosgroup-lab** blade, select the **Azure Cosmos DB** account you recently created.



Subscription (change)
LRN

Subscription ID
9103844d-1370-4716-b02b-69ce936865c6

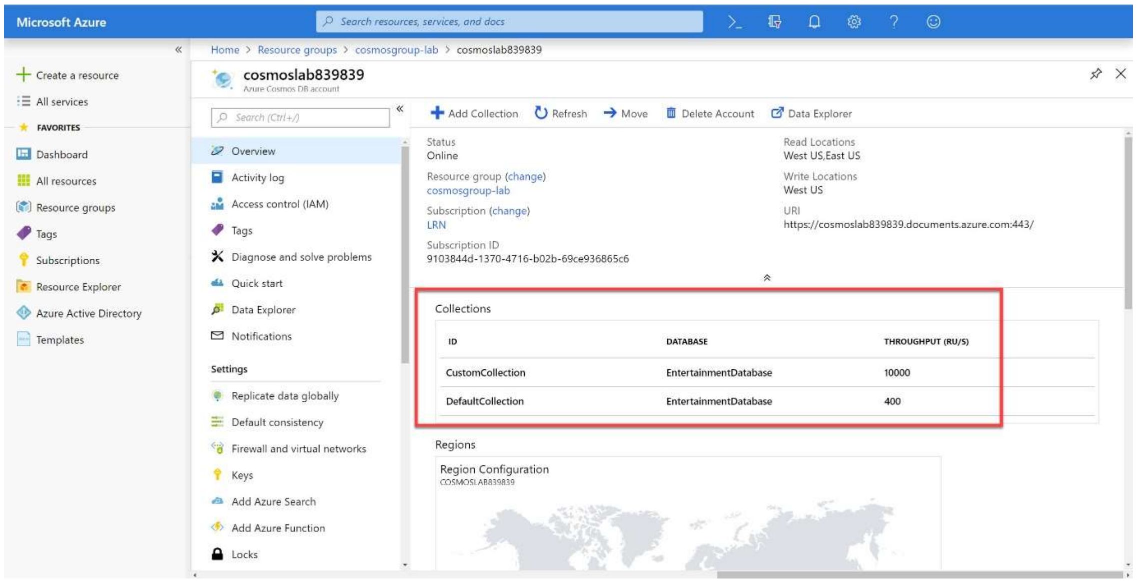
Deployments
1 Succeeded

Tags (change)
Click here to add tags

1 items

NAME	TYPE	LOCATION
cosmoslab839839	Azure Cosmos DB account	West US

5. In the **Azure Cosmos DB** blade, observe the new collections and database displayed in the middle of the blade.



Status
Online

Read Locations
West US,East US

Resource group (change)
cosmosgroup-lab

Write Locations
West US

Subscription (change)
LRN

URI
https://cosmoslab839839.documents.azure.com:443/

Subscription ID
9103844d-1370-4716-b02b-69ce936865c6

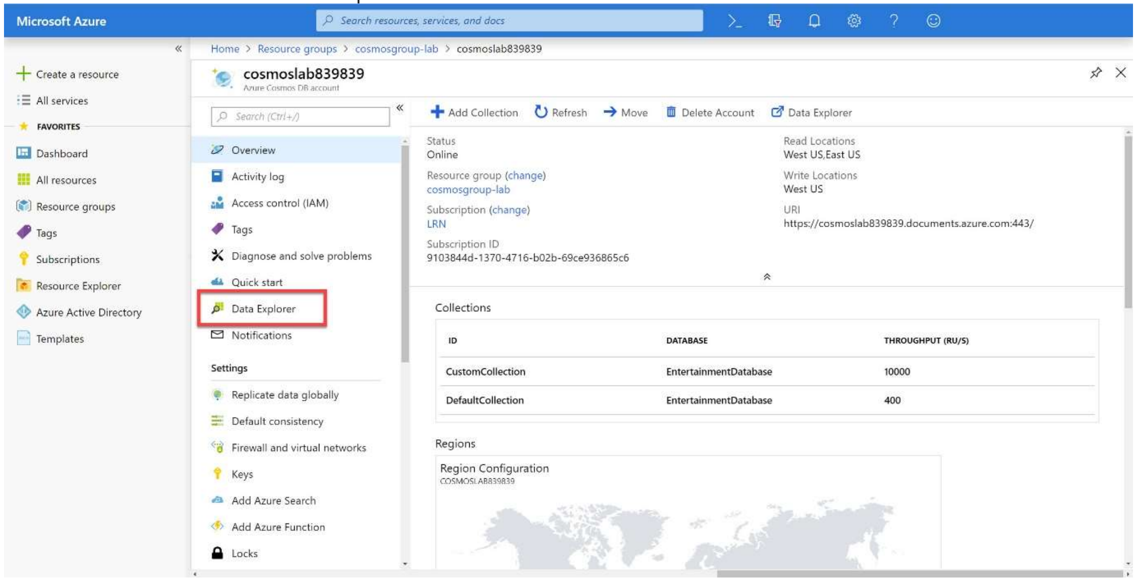
Collections

ID	DATABASE	THROUGHPUT (RU/S)
CustomCollection	EntertainmentDatabase	10000
DefaultCollection	EntertainmentDatabase	400

Regions

Region Configuration
COSMOSLAB839839

6. Locate and click the **Data Explorer** link on the left side of the blade.



Status
Online

Resource group (change)
cosmosgroup-lab

Subscription (change)
LRN

Subscription ID
9103844d-1370-4716-b02b-69ce936865c6

Read Locations
West US,East US

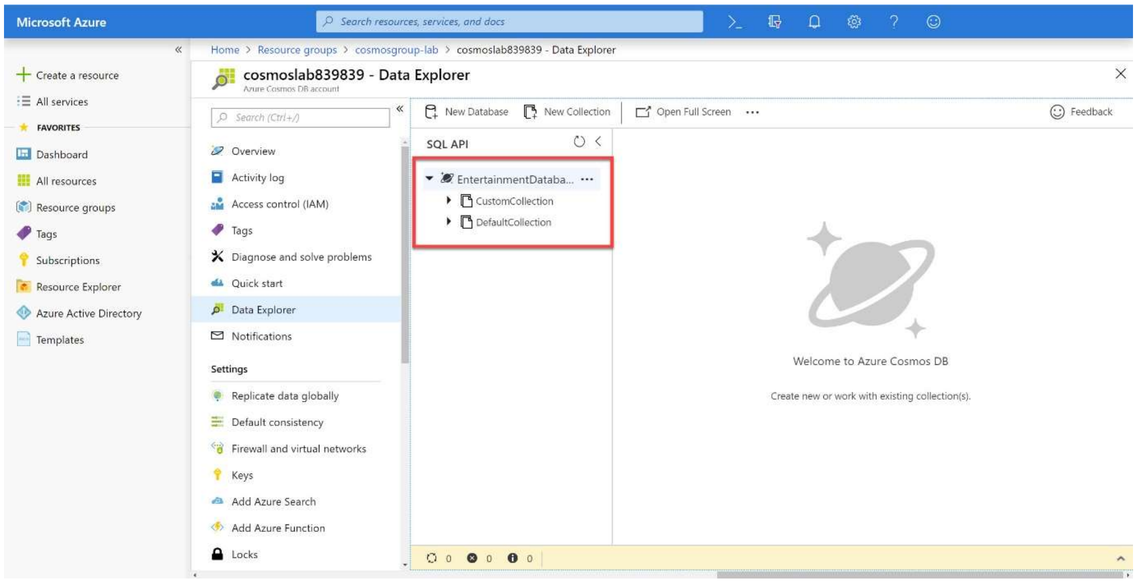
Write Locations
West US

URI
https://cosmoslab839839.documents.azure.com:443/

Collections

ID	DATABASE	THROUGHPUT (RU/S)
CustomCollection	EntertainmentDatabase	10000
DefaultCollection	EntertainmentDatabase	400

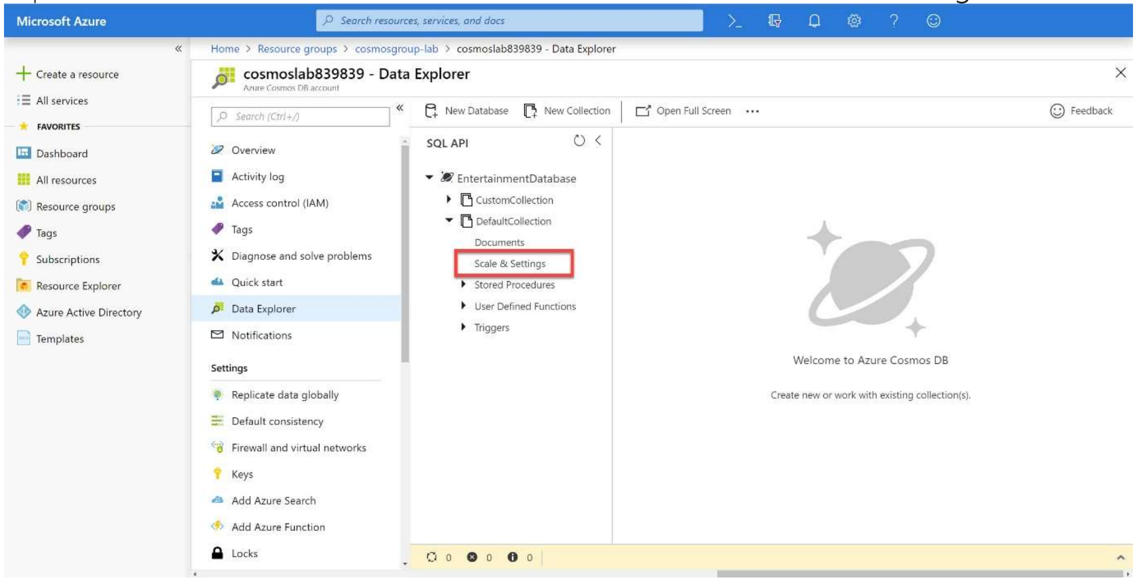
7. In the **Data Explorer** section, expand the **EntertainmentDatabase** database node and then observe the collection nodes.



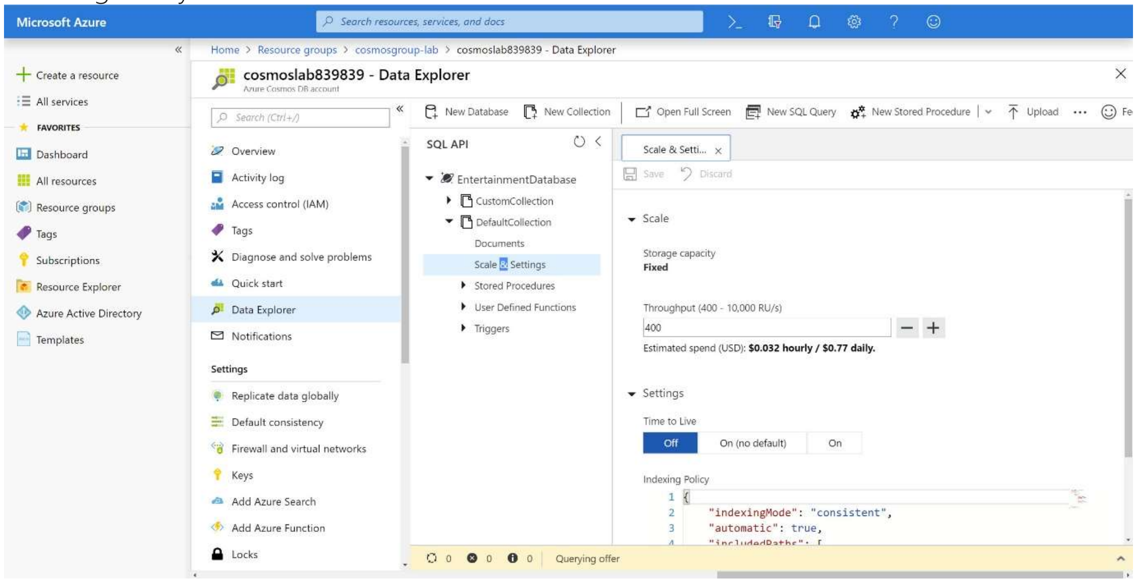
Welcome to Azure Cosmos DB

Create new or work with existing collection(s).

8. Expand the DefaultCollection node. Within the node, click the Scale & Settings link.



9. Observe the following properties of the collection:
   - Storage Capacity
   - Assigned Throughput
   - Indexing Policy



Scale

Storage capacity
Fixed

Throughput (400 - 10,000 RU/s)
400
Estimated spend (USD): **$0.032 hourly / $0.77 daily.**

Settings

Time to Live
[✓ Off] On (no default) On

Indexing Policy
```
{
    "indexingMode": "consistent",
    "automatic": true,
    "includedPaths": [
```

You will quickly notice that this is a fixed-size container that has a limited amount of RU/s. The indexing policy is also interesting as it implements a Hash index on string types and Range index on numeric types.

Index Policy for the collection

```
{
    "indexingMode": "consistent",
    "automatic": true,
    "includedPaths": [
        {
            "path": "/*",
            "indexes": [
                {
                    "kind": "Range",
                    "dataType": "Number",
                    "precision": -1
                },
                {
                    "kind": "Hash",
                    "dataType": "String",
                    "precision": 3
                }
            ]
        }
    ],
    "excludedPaths": []
}
```

10. Back in the Data Explorer section, expand the CustomCollection node. Within the node, click the Scale & Settings link.
11. Observe the following properties of the collection and compare them to the last collection:
    - Storage Capacity
    - Assigned Throughput
    - Partition Key
    - Indexing Policy
      You configured all of these values when you created this collection using the SDK. You should take time to look at the custom indexing policy you created using the SDK.

```json
{
    "indexingMode": "consistent",
    "automatic": true,
    "includedPaths": [
        {
            "path": "/*",
            "indexes": [
                {
                    "kind": "Range",
                    "dataType": "Number",
                    "precision": -1
                },
                {
                    "kind": "Range",
                    "dataType": "String",
                    "precision": -1
                }
            ]
        }
    ],
    "excludedPaths": []
}
```

12. Close your browser window displaying the Azure Portal.

Exercise 4 Populate Collections with Documents using the Python SDK

OK so now we go and populate the collection with 1000 documents containing one of 3 types of interactions

```
WatchLiveTelevisionChannel
PurchaseFoodOrBeverage
ViewMap
```

Populate the partitioned – custom collection using some python code to demonstrate that one can store differing document types within the collections.

Copy the code (3 blocks) below into a file called EntertainmentInt.py

```python
import azure.cosmos as cosmos
import azure.cosmos.cosmos_client as cosmos_client
import json
import random

def randListElem(inList):
    """ Return a random element from a list supplied as a parameter """
    retVal = inList[random.randint(0, len(inList)-1 )]
    return(retVal)

def watchLiveTelevisionChannel():
    """ Return a random watchLiveTV document as a dict """
    channelNames = ['BBC1', 'BBC2', 'ITV1', 'Channel 4', 'BBC News', 'Sky Sports 1',
                     'Sky Sports 2']
    minutesViewed = random.randint(1, 121)
    channelName = randListElem(channelNames)
    intType = 'Watch live TV'
    wltvc = {   "channelName" : channelName,
                "minutesViewed" : minutesViewed,
                "type" : intType}
    return wltvc
```

```python
def purchaseFoodBeverage():
    """ Return a random food or beverage purchase as a dictionary """
    foodItems = ['hotdog', 'veggie meat pie', 'crisps', 'meat and potato pie', 'peanuts'
                ]
    drinkItems = ['tea', 'Bovril', 'Hot Chocolate', 'Fanta', 'Diet Coke', 'Pepsi',
                'Coffee', 'bottled water']
    fbTypes = ['food', 'beverage']
    fbPrices = {"hotdog" : 0.45, "veggie meat pie" : 0.55, "crisps" : 0.25,
                "meat and potato pie" : 0.5, "peanuts" : 0.21 , "tea" : 0.10,
                "Bovril" : 0.15, "Hot Chocolate" : 0.15, "Fanta" : 0.2,
                "Diet Coke" : 0.2, "Pepsi" : 0.2, "Coffee" : 0.12,
                "bottled water" : 0.18 }

    fbType = randListElem(fbTypes)
    if fbType == 'food':
        fbItem = randListElem(foodItems)
        fbUnitPrice = fbPrices[fbItem]
        fbQuantity = random.randint(1, 12)

    elif fbType == 'beverage':
        fbItem = randListElem(drinkItems)
        fbUnitPrice = fbPrices[fbItem]
        fbQuantity = random.randint(1, 12)

    fbTotalPrice = fbQuantity * fbUnitPrice
    return(
            {"type" : fbType,
             "item" : fbItem,
             "unitPrice" : fbUnitPrice,
             "quantity" : fbQuantity,
             "totalPrice" : fbTotalPrice }
    )

def viewMap():
    """ Return a random map viewing event"""
    return(
        {"type" : "viewMap",
         "minutesViewed" : random.randint(1, 25) }
    )
```

```
if __name__ == "__main__":

    # get the access key and endpoint and set up the client
    with open('config.json', 'r') as f:
        config = json.load(f)
    client = cosmos_client.CosmosClient(config['endPoint'],
                                {'masterKey':    config['key']})

    databaseID = 'EntertainmentDatabase'
    collectionID = 'DefaultCollection'
    database_link = 'dbs/' + databaseID
    collection_link = database_link + '/colls/' + collectionID
    NofDocsToCreate = 1000


    for cnt in range(NofDocsToCreate +1):
        # Create a random entertainment event instance and persist it to Cosmos
        entTypes = ["viewMap", "beverage", "food", "Watch live TV"]
        entInstType = randListElem(entTypes)
        if entInstType == "viewMap":
            entInst = viewMap()
        elif entInstType == "food" or entInstType == "beverage":
            entInst = purchaseFoodBeverage()
        else:
            entInst = watchLiveTelevisionChannel()

        client.CreateItem(collection_link, entInst)
        print('.', end = '')

    print("\nWritten {0} items into {1} collection".format(cnt, collectionID))
```

Once you have copied the code into EntertainmentInt.py execute the script using the Visual Studio Code F5 key and the program will create and insert 1000 documents into the collection.

Go to the Azure Portal and look at the documents in the Data Explorer > CustomCollection > Documents tab. Note that the collection contains document of different types with different attributes. This is fine in CosmosDB collections.

Note also that every document has an id field populated by a globally unique user id (GUID). CosmosDB will automatically populate this field – it must be unique for each document and you can specify a value for it in your code (but you need to make sure it is a unique identifier).

Exercise 5 Benchmark A Simple Collection using a .NET Core Application

In the next part of this lab, you will compare various partition key choices for a large dataset using a special benchmarking tool available on GitHub.com. First, you will learn how to use the benchmarking tool using a simple collection and partition key.

Clone Existing .NET Core Project

On your local machine, create a new folder that will be used to contain the content of your new .NET Core project.

In the new folder, right-click the folder and select the Open with Code menu option.

> Alternatively, you can run a command prompt in your current directory and execute the `code .` command.

In the Visual Studio Code window that appears, right-click the Explorer pane and select the Open in Command Prompt menu option.

In the open terminal pane, enter and execute the following command:

```
git clone https://github.com/seesharprun/cosmos-benchmark.git .
```

This command will create a copy of a .NET Core project located on GitHub (https://github.com/seesharprun/cosmos-benchmark) in your local folder.

Visual Studio Code will most likely prompt you to install various extensions related to .NET Core or Azure Cosmos DB development. None of these extensions are required to complete the labs.

In the terminal pane, enter and execute the following command:

```
dotnet restore
```

> This command will restore all packages specified as dependencies in the project.

1. In the terminal pane, enter and execute the following command:

```
dotnet build
```

> This command will build the project.

2. Click the ✕ symbol to close the terminal pane.
3. Observe the Program.cs and benchmark.csproj files created by the .NET Core CLI.
4. Double-click the sample.json link in the Explorer pane to open the file in the editor.
5. Observe the sample JSON file

> This file will show you a sample of the types of JSON documents that will be uploaded to your collection. Pay close attention to the **Submit*** fields, the **DeviceId** field and the **LocationId** field.

Update the Application's Settings

1. Double-click the appsettings.json link in the Explorer pane to open the file in the editor.
2. Locate the /cosmosSettings.endpointUri JSON path:

```
"endpointUri": ""
```

3. Update the endPointUri property by setting it's value to the URI value from your Azure Cosmos DB account that you recorded earlier in this lab:

> For example, if your **uri** is `https://cosmosacct.documents.azure.com:443/`, your new property will look like this: `"endpointUri": "https://cosmosacct.documents.azure.com:443/"`.

4. Locate the /cosmosSettings.primaryKey JSON path:

```
"primaryKey": ""
```

Update the primaryKey property by setting it's value to the PRIMARY KEY value from your Azure Cosmos DB account that you recorded earlier in this lab:

> For example, if your **primary key** is `elzirrKCnXlacvh1CRAnQdYVbVLspmYHQyYrhx0PltHi8wn5lHVHFnd1Xm3ad5cn4TUcH4U0MSeHsVykkFPHpQ==`, your new property will look like this: `"primaryKey": "elzirrKCnXlacvh1CRAnQdYVbVLspmYHQyYrhx0PltHi8wn5lHVHFnd1Xm3ad5cn4TUcH4U0MSeHsVykkFPHpQ=="`.

Configure a Simple Collection for Benchmarking

Double-click the appsettings.json link in the Explorer pane to open the file in the editor.

Locate the /collectionSettings JSON path:

```
"collectionSettings": [],
```

Update the collectionSettings property by setting it's value to the following array of JSON objects:

```
 "collectionSettings": [
     {
         "id": "CollectionWithHourKey",
         "throughput": 10000,
         "partitionKeys": [ "/SubmitHour" ]
     }
 ],
```

The object above will instruct the benchmark tool to create a single collection and set it's throughput and partition key to the specified values. For this simple demo, we will use the hour when an IoT device recording was submitted as our partition key.

Collection Name	Throughput	Partition Key
CollectionWithHourKey	10000	/SubmitHour

Save all of your open editor tabs.

Run the Benchmark Application

1. In the Visual Studio Code window, right-click the Explorer pane and select the Open in Command Prompt menu option.
2. In the open terminal pane, enter and execute the following command:

```
dotnet run
```

3. Observe the results of the application's execution. Your results should look very similar to the code sample below:

```
DocumentDBBenchmark starting...
 Database Validated:     dbs/MOEFAA==/
```

```
Collection Validated:   dbs/MOEFAA==/colls/MOEFAN6FoQU=/
Summary:
---------------------------------------------------------------------
Endpoint:               https://cosmosacct.documents.azure.com/
Database                IoTDeviceData
Collection              CollectionWithHourKey
Partition Key:          /SubmitHour
Throughput:             10000 Request Units per Second (RU/s)
Insert Operation:       100 Tasks Inserting 1000 Documents Total
---------------------------------------------------------------------

Starting Inserts with 100 tasks
Inserted 1000 docs @ 997 writes/s, 7220 RU/s (19B max monthly 1KB reads)

Summary:
---------------------------------------------------------------------
Total Time Elapsed:     00:00:01.0047125
Inserted 1000 docs @ 995 writes/s, 7209 RU/s (19B max monthly 1KB reads)
---------------------------------------------------------------------
```

The benchmark tool tells you how long it takes to write a specific number of documents to your collection. You also get useful metadata such as the amount of **RU/s** being used and the total execution time. We are not tuning our partition key choice quite yet, we are simply learning to use the tool.

4. Press the ENTER key to complete the execution of the console application.

Update the Application's Settings

Double-click the appsettings.json link in the Explorer pane to open the file in the editor.

Locate the /cosmosSettings.numberOfDocumentsToInsert JSON path:

```
"numberOfDocumentsToInsert": 1000
```

Update the numberOfDocumentsToInsert property by setting it's value to 50,000:

```
"numberOfDocumentsToInsert": 50000
```

Save all of your open editor tabs.

Run the Benchmark Application

1. In the Visual Studio Code window, right-click the Explorer pane and select the Open in Command Prompt menu option.
2. In the open terminal pane, enter and execute the following command:

```
dotnet run
```

3. Observe the results of the application's execution.
4. Observe the amount of time required to import multiple records.
5. Press the ENTER key to complete the execution of the console application.

Benchmark Various Partition Key Choices using a .NET Core Application

Now you will use multiple collections and partition key options to compare various strategies for partitioning a large dataset.

Configure Multiple Collections for Benchmarking

1. Double-click the appsettings.json link in the Explorer pane to open the file in the editor.
2. Locate the /collectionSettings JSON path:

```
"collectionSettings": [],
```

Update the collectionSettings property by setting it's value to the following array of JSON objects:

```
"collectionSettings": [
     {
         "id": "CollectionWithMinuteKey",
         "throughput": 10000,
         "partitionKeys": [ "/SubmitMinute" ]
     },
     {
         "id": "CollectionWithDeviceKey",
         "throughput": 10000,
         "partitionKeys": [ "/DeviceId" ]
     }
 ],
```

The object above will instruct the benchmark tool to create multiple collections and set their throughput and partition key to the specified values. For this demo, we will compare the results using each partition key.

Collection Name	Throughput	Partition Key
CollectionWithMinuteKey	10000	/SubmitMinute
CollectionWithDeviceKey	10000	/DeviceId

3. Save all of your open editor tabs.

Run the Benchmark Application

1. In the Visual Studio Code window, right-click the Explorer pane and select the Open in Command Prompt menu option.
2. In the open terminal pane, enter and execute the following command:

```
dotnet run
```

3. Observe the results of the application's execution.

The timestamp on these IoT records is based on the time when the record was created. We submit the records as soon as they are created so there's very little latency between the client and server timestamp. Most of the records being submitted will be within the same minute so they share the same SubmitMinute partition key. This will cause a hot partition key and can constraint throughput. In this context, a hot partition key refers to when requests to the same partition key exceed the provisioned throughput and are rate-limited. A hot partition key causes high volumes of data to be stored within the same partition. Such uneven distribution is inefficient. In this demo, you should expect a total time of >20 seconds.

```
---------------------------------------------------------------------
 Collection              CollectionWithMinuteKey
 Partition Key:          /SubmitMinute
 Total Time Elapsed:     00:00:57.4233616
 Inserted 50000 docs @ 871 writes/s, 6304 RU/s (16B max monthly 1KB reads)
 ---------------------------------------------------------------------
```

The SubmitMinute partition key will most likely take longer to execute than the DeviceId partition key. Using the DeviceIdpartition key creates a more even distribution of requests across your various partition keys. Because of this behavior, you should notice drastically improved performance.

```
---------------------------------------------------------------------
 Collection              CollectionWithDeviceKey
 Partition Key:          /DeviceId
 Total Time Elapsed:     00:00:27.2769234
 Inserted 50000 docs @ 1833 writes/s, 13272 RU/s (34B max monthly 1KB
reads)
 ---------------------------------------------------------------------
```

4. Compare the RU/s and total time for both collections.
5. Press the ENTER key to complete the execution of the console application.

Observe the New Collections and Database in the Azure Portal

1. Return to the Azure Portal (http://portal.azure.com).
2. On the left side of the portal, click the Resource groups link.
3. In the Resource groups blade, locate and select the cosmosgroup-lab *Resource Group*.
4. In the cosmosgroup-lab blade, select the Azure Cosmos DB account you recently created.
5. In the Azure Cosmos DB blade, locate and click the Data Explorer link on the left side of the blade.
6. In the Data Explorer section, expand the IoTDeviceData database node and then observe the various collection nodes.
7. Expand the CollectionWithDeviceKey node. Within the node, click the Scale & Settings link.
8. Observe the following properties of the collection:
9. Storage Capacity
10. Assigned Throughput
11. Indexing Policy
12. Click the New SQL Query button at the top of the Data Explorer section.
13. In the query tab, replace the contents of the *query editor* with the following SQL query:

```sql
SELECT VALUE COUNT(1) FROM recordings
```

14. Click the Execute Query button in the query tab to run the query.
15. In the Results pane, observe the results of your query.
16. Back in the Data Explorer section, right-click the IoTDeviceData database node and select the Delete Database option.

Since you created multiple collections in this database with high throughput, it makes sense to dispose of the database immediately to minimize your Azure subscription consumption.

17. **In the** Delete Database **popup enter the name of the database (**IoTDeviceData and EntertainmentDatabase**) in the field and then press the** OK **button.**
18. Close your browser application.