Developing Event-Driven Solutions with AWS Lambda

(LAB-M08-01)

Version Control	
Document	Developing Event-Driven Solutions with AWS Lambda
Owner	Ahmad Majeed Zahoory
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Description of Change	Task steps updated

Lab duration: **40 minutes**

Lab scenario

In this lab, you will learn how to use AWS Lambda to trigger a Lambda function when objects are uploaded into an Amazon S3 bucket.

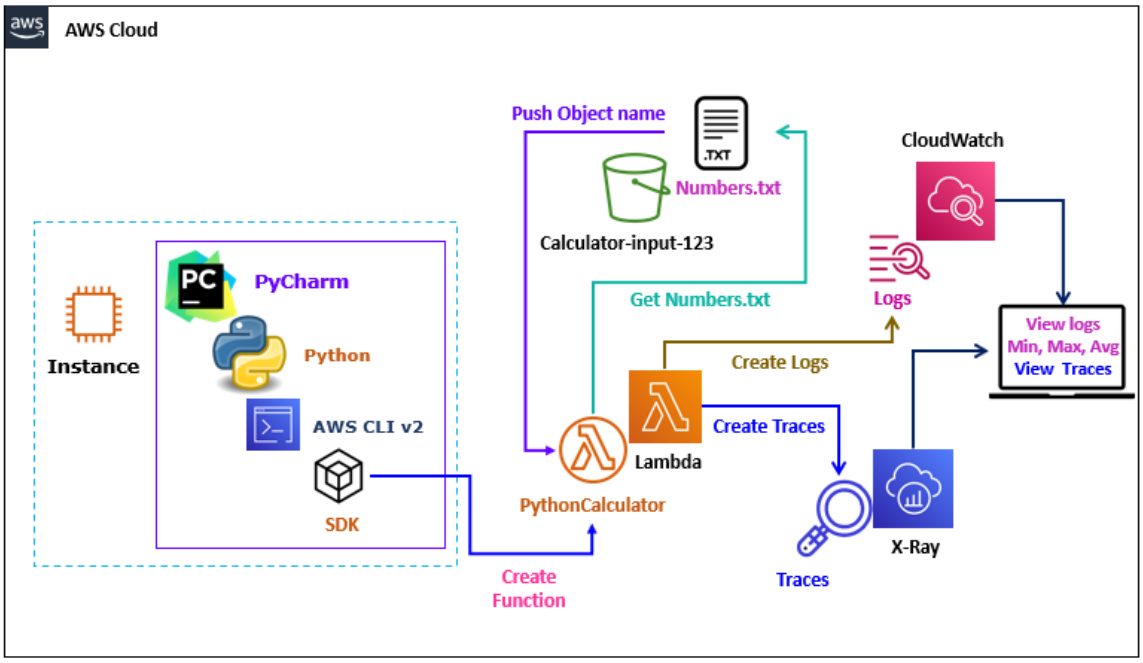
The Lambda function will calculate the minimum, maximum, and average of the numbers contained in an object uploaded to the Amazon S3 bucket.

The terms *file* and *object* are used interchangeably when referring to the contents of Amazon S3 buckets.

Objectives

After you complete this lab, you will be able to:

- Create new lambda function.
- Create a new bucket.
- Upload object in the bucket.
- Get object from the bucket.
- Process object using lambda function.
- View the lambda logs in cloud watch.
- View the lambda traces in x-Ray.



Task 1: Manage IAM user and Role

In this task, you will update the AWS IAM role with permission to manage the S3 and Lambda.

Step 1: Update the IAM User Permission

1. In the **AWS Management Console**, on the **Services** menu, search and select **IAM**.
2. Select **Users**.
    a. Open the **Dev-User-YOUR-ID**.
        i. Select **Permissions**.
            a) Select **AmazonEC2FullAccess**.
            b) Select **AmazonDynamoDBFullAccess**.
                1) Select **Remove**.
                I. Select **Remove Policies**.
3. From the **Dev-User** console:
    a. Select **Permissions**.
        i. Select **Add permissions**.
            a) Select **Add permissions**.
    b. In the **Add permissions** page:
        i. **Permissions options**: Select **Attach policies directly**.
        ii. **Permissions policies**:
            a) Search and select **AmazonS3ReadOnlyAccess**.
            b) Select **Next**.

1) Select **Add permissions**.

c. In the **Add permissions** page:

i. **Permissions options**: Select **Attach policies directly**.

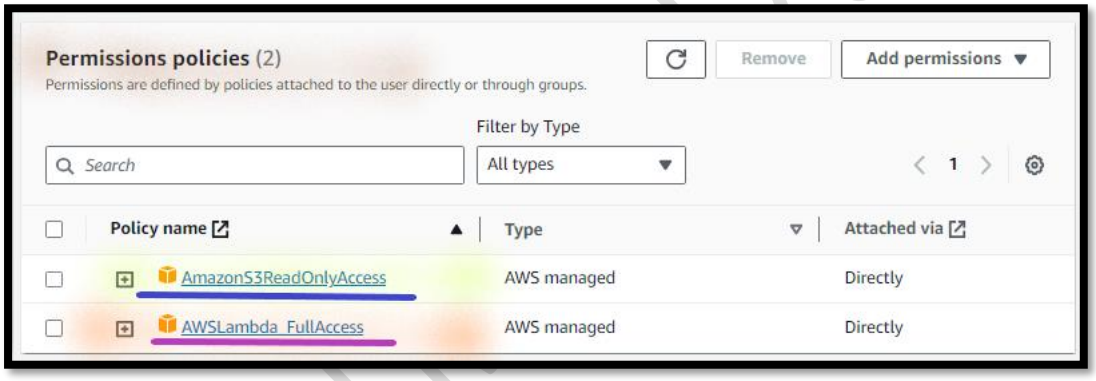
ii. **Permissions policies**:

a) Search and select **AWSLambda_FullAccess**.

b) Select **Next**.

1) Select **Add permissions**.

Note: You can see the **AmazonS3ReadOnlyAccess** and **AWSLambda_FullAccess** under the **Permissions policies**.



Step 2: Create IAM Role

4. **From** the **IAM** console.

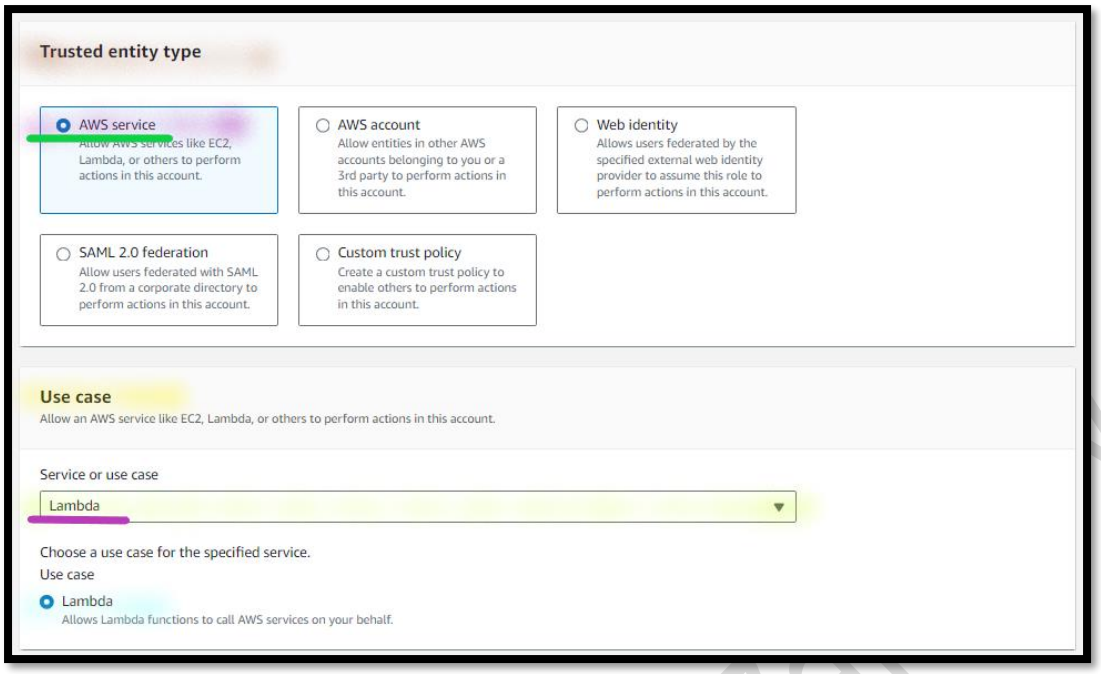
5. Select **Roles**.

a. Click on **Create role**.

i. In the **Select trusted entity** section.

a) **Trusted entity type**: Select **AWS service**.

b) **Use cases**: Dropdown and select **Lambda**.

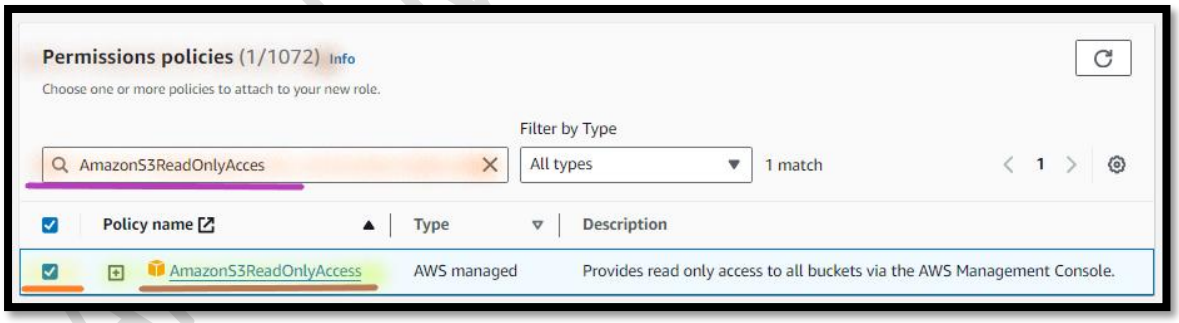


c) Select **Next**.

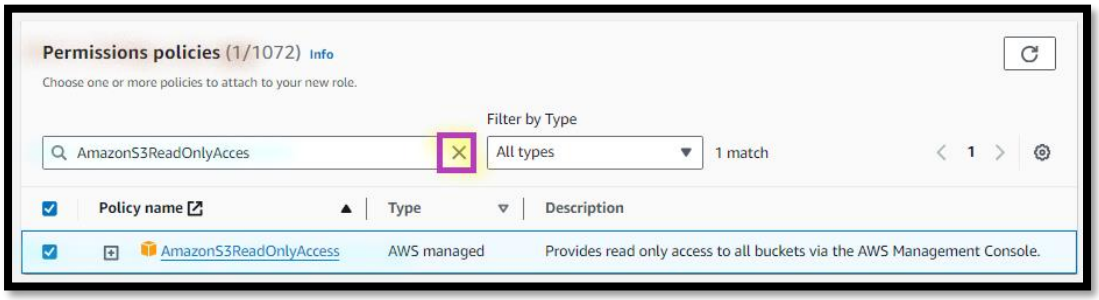
ii. In the **Add permissions** section.

a) In the **Search box**, write **AmazonS3ReadOnlyAccess** and select **Enter Key**.

1) Select **AmazonS3ReadOnlyAccess**.



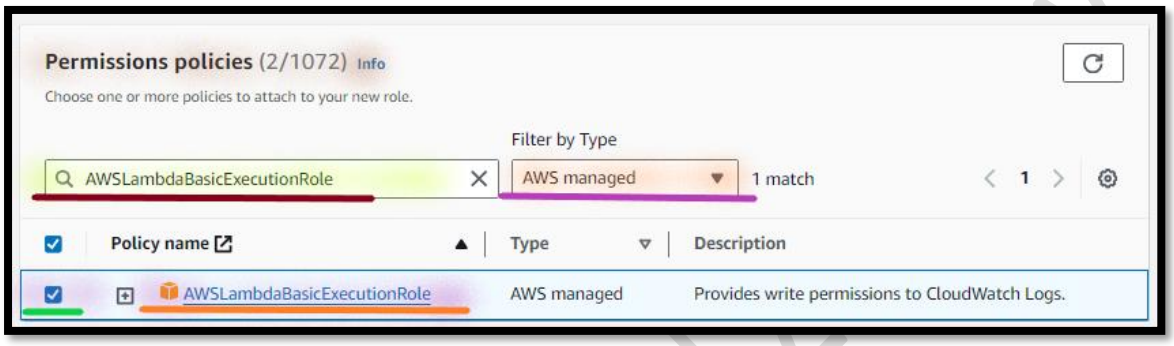
2) Select **Clear search query**.



b) In the **Search box**, write **AWSLambdaBasicExecutionRole** and select **Enter Key**.

1) **Filter by type**: Dropdown and select **AWS managed**.

2) Select the **AWSLambdaBasicExecutionRole**.

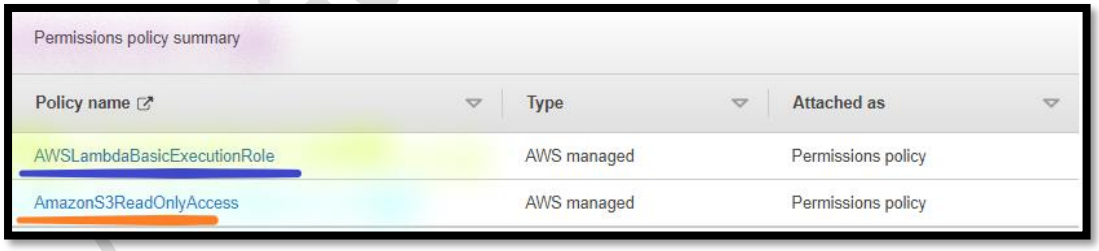


c) Select **Next**.

ii. In the **Name, review, and create** section.

a) **Role name**: Write **Lambda-S3-Role-YOUR-ID**.

Note: You can see the **AmazonS3ReadOnlyAccess** and **AWSLambdaBasicExecutionRole** policy under the **Permissions Policy summary** section.

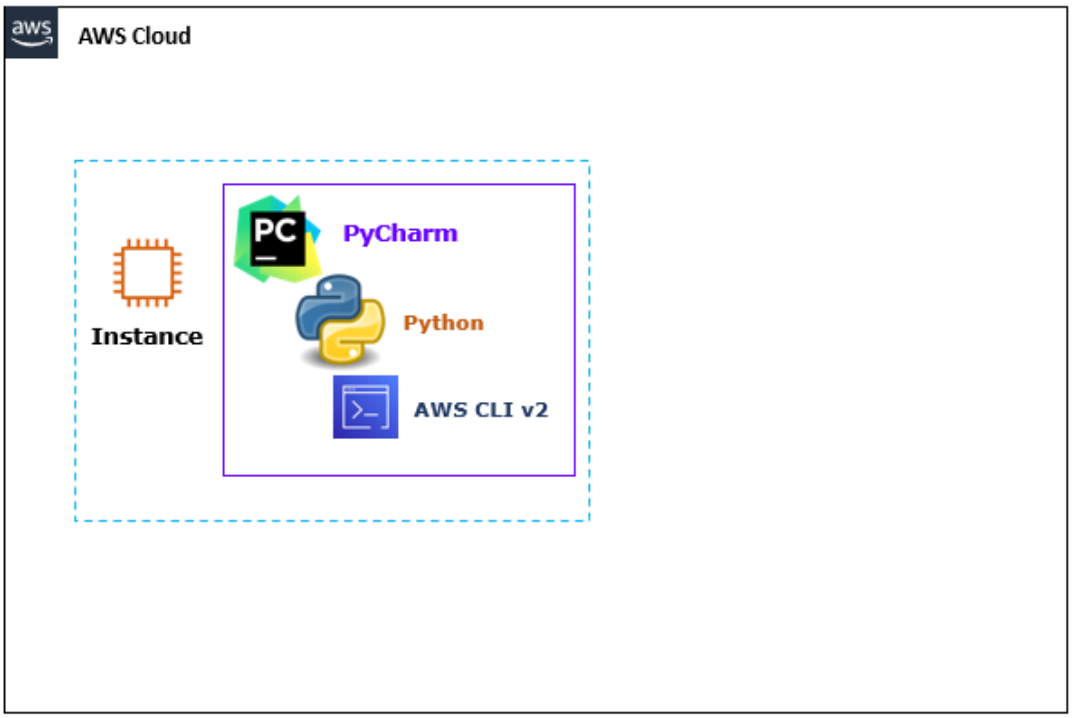


b) Click **Create role**.

Note: **Wait**, till you can see the **message** "**Role Lambda-S3-Role created**".

Task 2: Build Server for Development Environment

In this task, you will build the development environment with Python, PyCharm and AWS CLI.



Step 1: Create EC2 Instances

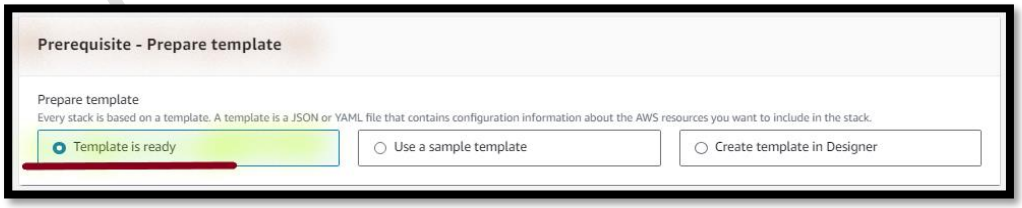
6. In the **AWS Management Console**, on the **Services** menu Search and Select **CloudFormation**.

7. Choose the **YOUR ALLOCATED REGION** list to the right of your account information on the navigation bar.

8. Select **Create stack** and configure:

   a. In the **Create stack** page:

      i. **Prepare template**: Select **Template is ready**.



      ii. **Template source**: Select **Upload a template file**.

      iii. **Choose file**: Click on **Choose file**.

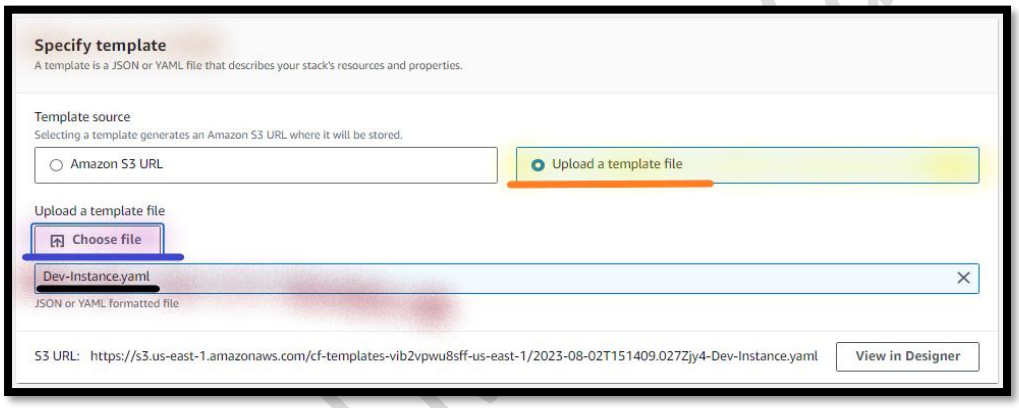
a) **Navigate** and **select** the **Dev-Instance**.yaml file.

Note: **Dev-Instance**.yaml template is provided with the Lab manual.

Note: AWS template **performing** the **following** tasks:

1. **Creating Windows instances**.
2. **Creating t2.medium** instance (2 vCPU and 4 GB) [*This instance type attract charges*].
3. **Set** the **Administrator's Password**.

Note: You can also use **t2.micro**, but the **performance will be low** to build development environment.



iv. Select **Next**.

b. In the **Specify stack details** page:

i. **Stack name**: Write **Dev-Instance-PY**.

Note: Leave other details as default.

ii. Select **Next**.

c. In the **Configure stack options** page:

Note: Leave all the details as default.

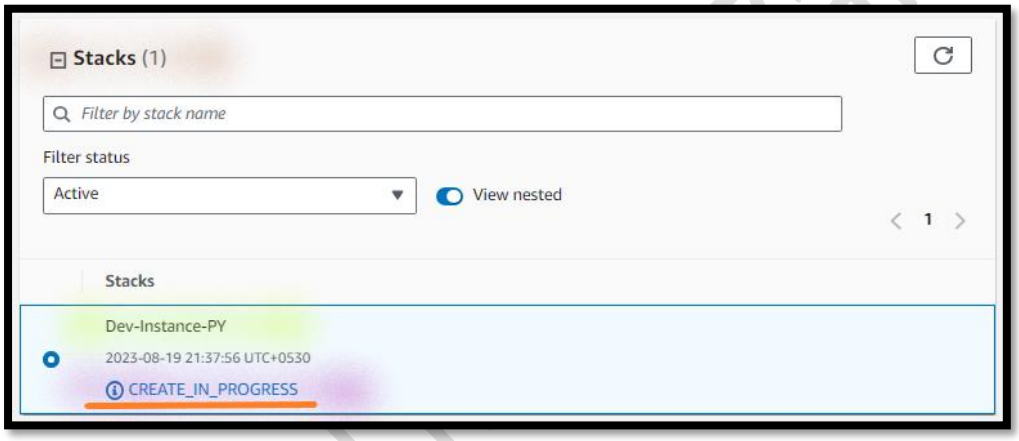
i. Select **Next**.

d. In the **Review Dev-Instance-PY** page:

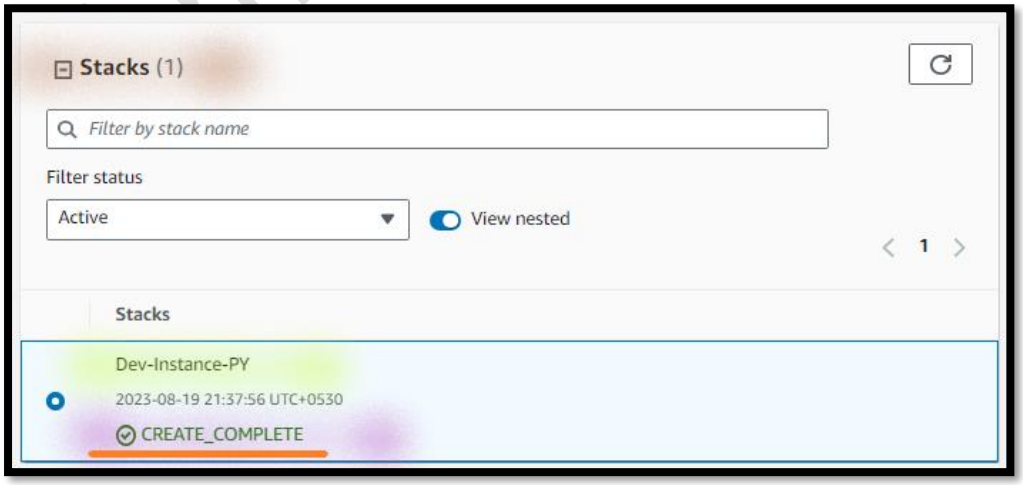
Note: Review all the details.

i. Select **Submit**.

Note: You can see the **Stack** status as **CREATE_IN_PROGRESS**.



Note: **Wait**, till you can see the **Stack** status as **CREATE_COMPLETE**. You can **Refresh** your screen

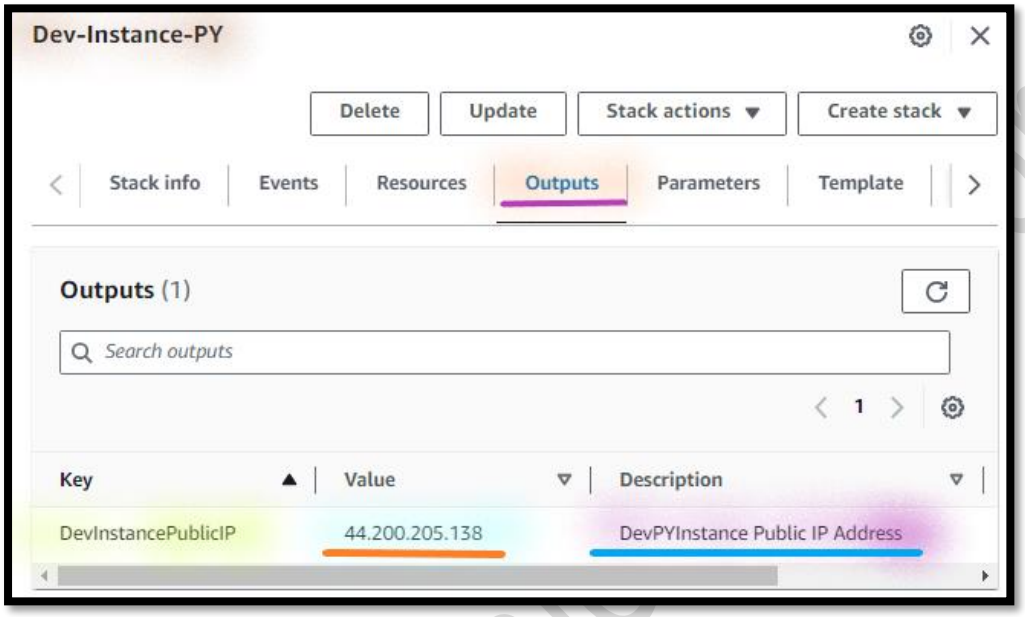


Step 2: View the Output

9. **From** the **Dev-Instance-PY** **CloudFormation** console:

   a. Select **Outputs**.

Note: **Copy** the **DevPYInstance Public IP** address in the **Notepad**.



Step 3: Connect to Instance

10. From the **Local Desktop/ Laptop** (*Windows Desktop*), right click on **Start** & **Run**.

    a. In the **Open**, write **mstsc**.

    b. Select **Ok**.

       i. **From** the **Remote Desktop Connection**:

          a) **Computer**: Write the **Public IP Address** of the **DevPYInstance**.

          b) Select **Connect**.

Note: You can **get the prompt** to enter the **Username** and **Password**.

1) **Username:** Write **Administrator**.

2) **Password**: Write **lab-password@123**.

3) Select **Ok**.

Step 4: Install the Python

11. From the **DevPYInstance** (*Windows Server 2022*).

    a. **Download** the **Python 3.11** for **Windows x64**.

Note: Use the below URL to download the **Python 3.11** for **Windows**.

https://bitbucket.org/ahmadzahoory/dev/downloads/python-3.11.4-amd64.exe

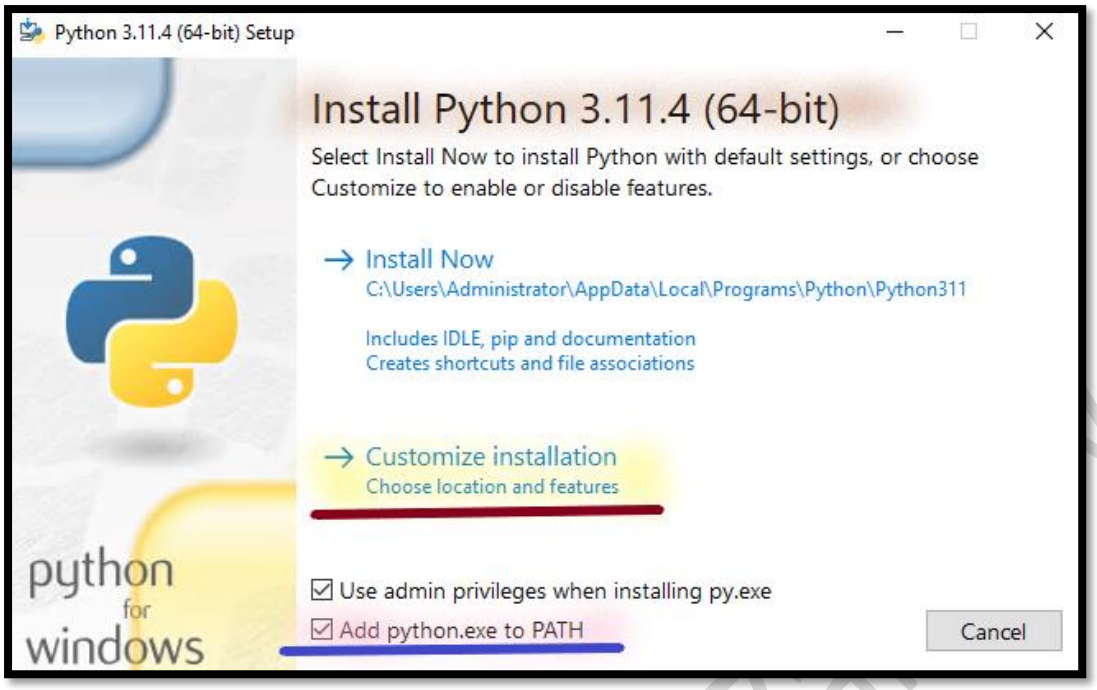
Info: You can also download the Python 3.11 from the Python.og site.
https://www.python.org/downloads/release/python-3119/

    b. **Install** the ***Python*** for **Windows x64**.

        i. From the **Install Python 3.11** section:

            a) **Add python.exe to PATH**: **Enable** the **Checkmark**.

            b) Select **Custom installation**.

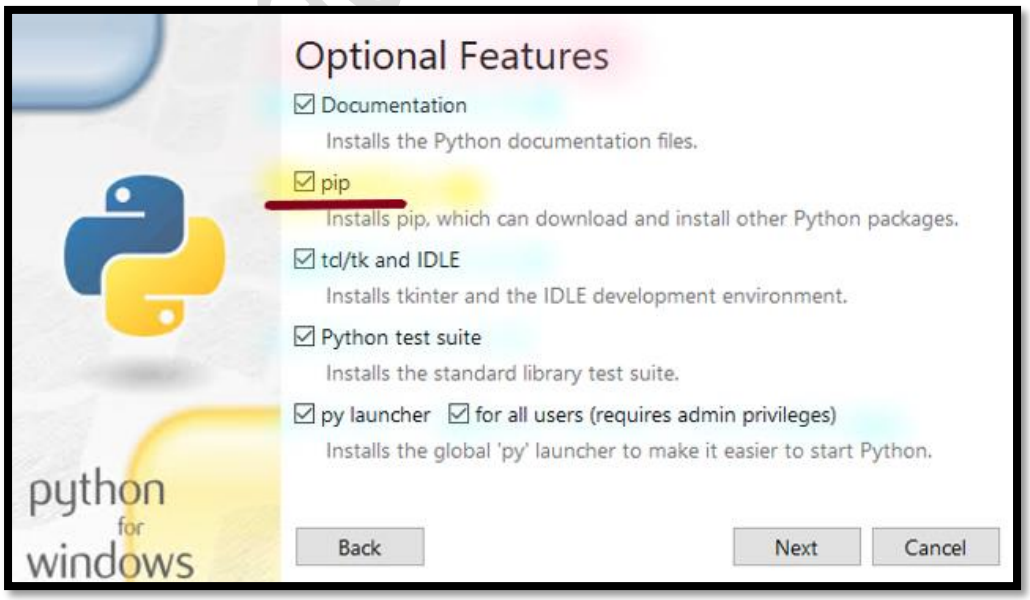


ii. From the **Optional Features** section:

a) Select **All Options**.

Note: Leave all the options as default.

Note: Ensure **pip must** be **selected**.



a) Select **Next**.

iii. From the **Advanced Options** section:

Note: Leave all the options as default.

1) Select **Install**.

Note: **Wait**, till **Python 3.11** install **succesfully**.

Step 5: Check the Python and Pip Version

12. From the **DevPYInstance**, right click on **Start** & **Run**.

a. In the **Open**, write **cmd**.

b. Select **Ok**.

i. From the **Command line interpreter**:

a) **Execute** the ***below command*** to **verify** the **Python version**:

```
py --version
```

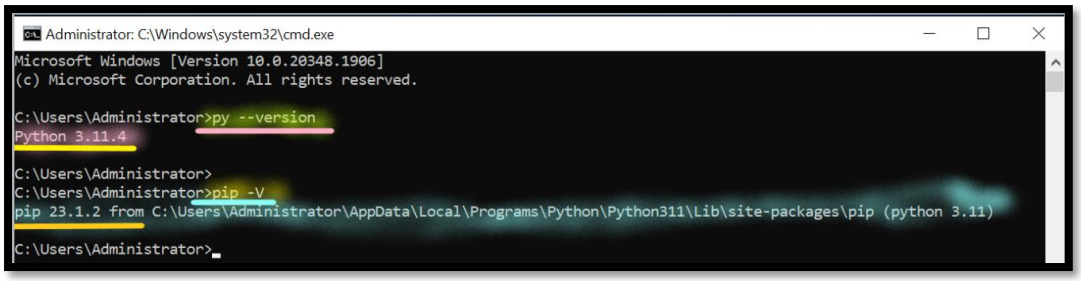
Note: You can see the **Python** installed **version**.

ii. From the **Command line interpreter**:

a) **Execute** the ***below command*** to **verify** the **PIP version**:

```
pip -V
```

Note: You can see the **Pip** installed **version**.



Step 6: Install the PyCharm IDE

13. **Download** and **Install** the **PyCharm IDE 20204** for **Community Edition**.

Note: Use the below **URL** to download the **PyCharm IDE**.

https://bitbucket.org/ahmadzahoory/devenv/downloads/pycharm-community-2024.1.1.exe

Info: You can also download the Pycharm 2024 from the jetbrains.com site.
https://www.jetbrains.com/pycharm/download/

Note: **Wait**, till **PyChram IDE** install **succesfully**.

Note: **Don't launch** the **PyCharm IDE**.

Step 7: Install the AWS CLI V2

14. From the **DevPYInstance**.

    a. **Download** and **install** the ***AWS CLI v2***.

Note: Use the below URL to download the **AW CLI v2**.

https://aws.amazon.com/cli/

Note: **Wait**, till **AWS CLI v2** install **succesfully**.

Step 8: Check the AWS CLI Version

15. From the **DevPYInstance**, right click on **Start** & **Run**.
    a. In the **Open**, write **cmd**.
    b. Select **Ok**.
        i. From the **Command line interpreter**:
            a) **Execute** the ***below command*** to **verify** the **AWS version**.

```
aws --version
```

Note: You can see the **AWS CLI** installed **version**.

Note: If you can see the "**'aws' is not recognized as an internal or external command**" message, **Restart** the **DevPYInstance**.

Step 9: Configure the Credentials and Configuration

16. From the **DevPYInstance**, right click on **Start** & **Run**.

    a. In the **Open**, write **cmd**.

    b. Select **Ok**.

        i. From the **Command line interpreter**:

            a) **Execute** the ***below command*** to **configure** the **AWS credentials**.

```
aws configure
```

a) **AWS Access Key ID**: Type **Dev-User-YOUR-ID's**, **access key** (*copy from the .csv file*), press **Enter** key to continue.

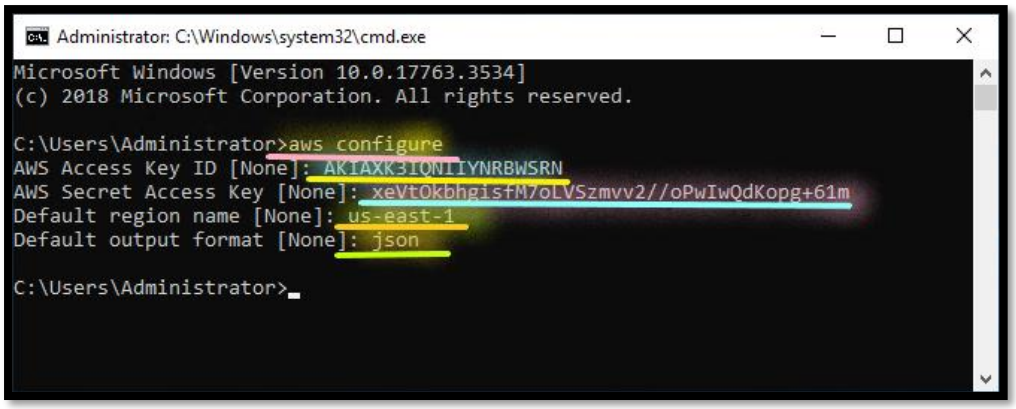
b) **AWS Secret Access Key**: Type **Dev-User-YOUR-ID's**, **secret access key** (*copy from the .csv file*), press **Enter** key to continue.

Note: Copy the **access key** and **secret access key** of the IAM user **Dev-User** from **.csv file** which you have downloaded in the previous step.

c) **Default region name**: Type **YOUR ALLOCATED REGION-ID**, press **Enter** key to continue.

Note: **Replace** the **region-identifier**.
Refer the **link** to know your **respective region region identifier**
https://docs.aws.amazon.com/AWSEC2/latest/UserGuide/using-regions-availability-zones.html

d) **Default output format**: Type **json**, press **Enter** key to continue.



b) **Execute** the ***below command*** to **exit**.

```
exit
```

Step 10: Verify the Configuration

17. From the **DevJPYInstance**, right click on **Start** & **Run**.

    a. In the **Open**, write **C:\Users\Administrator**.

    b. Select **Ok**.

    i. From the **File explorer**:

    a) **Open** the **.aws** folder.

    b) **Open** the **Credentials** file in **Notepad**.

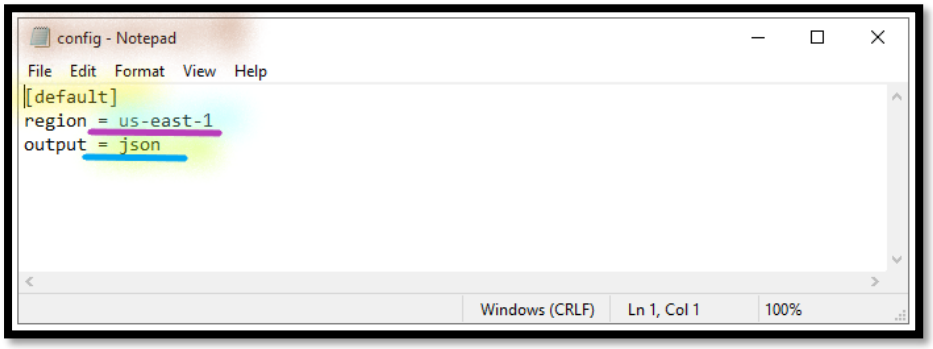
Note: You can see the **access key** and **secret access key** details.

1) Select **File**.

2) Select **Exit**.

b) **Open** the **Config** file in **Notepad**.

Note: You can see the **region** and **output** format details.



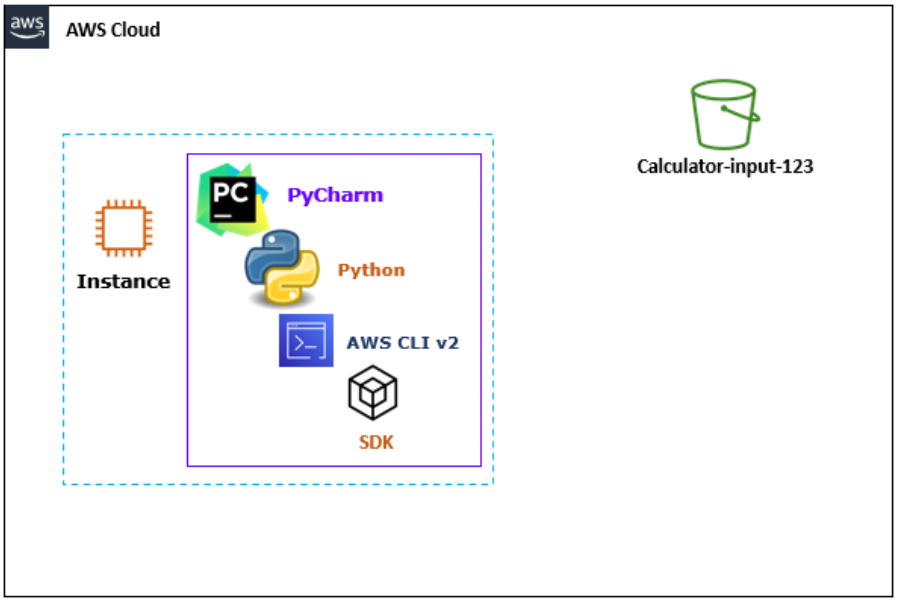
1) Select **File**.

2) Select **Exit**.

c) **Close** the **File explorer**.

Task 3: Create AWS S3 Bucket

In this task, you will create an input Amazon S3 bucket for your Lambda function to use.



Step 1: Create a Bucket

18. In the **AWS Management Console**, on the **Services** menu, search and select **S3**.

19. Choose the **YOUR ALLOCATED REGION** list to the right of your account information on the navigation bar.

20. Select **Create bucket**.

    a. **In the General Configuration section:**

        i. **Bucket type**: Select **General purpose**.

        ii. **Bucket name**: Write **calculator-input-123**.

Note: **Replace 123** with a **random number** to make bucket name unique.

Note: Leave other details as default.

    b. Select **Create bucket**.

Note: **Wait**, till bucket **calculator-input-123** gets **created**.

Step 2: Upload Content in the Bucket

21. **From** the **S3** console.

22. Open **calculator-input-123** bucket.

    a. Select **Objects**.

        i. Click **Upload**.

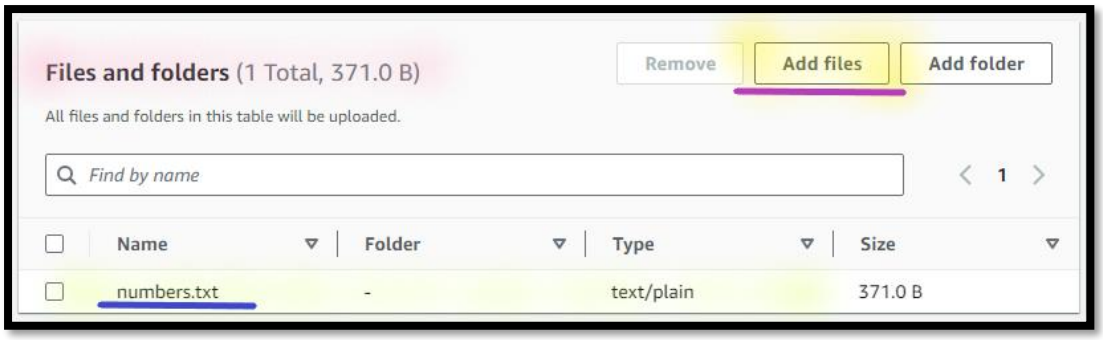
            a) Click **Add files**.

                1) **Navigate** and select **numbers**.txt file.

                I. Select **Open**.

Note: **numbers.txt** file is provided with the **Lab manual**.

Note: Once uploaded you can see the **numbers.txt** file under **files and folders** section.

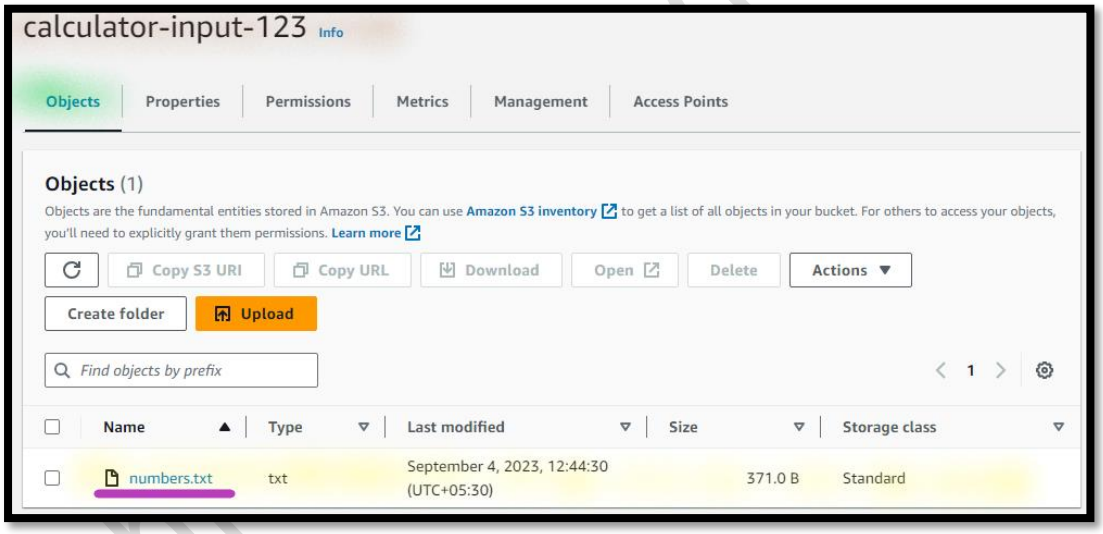


i. Select **Upload**.

Note: **Wait**, till file gets **uploaded succesfully**.

ii. Select **Close**.

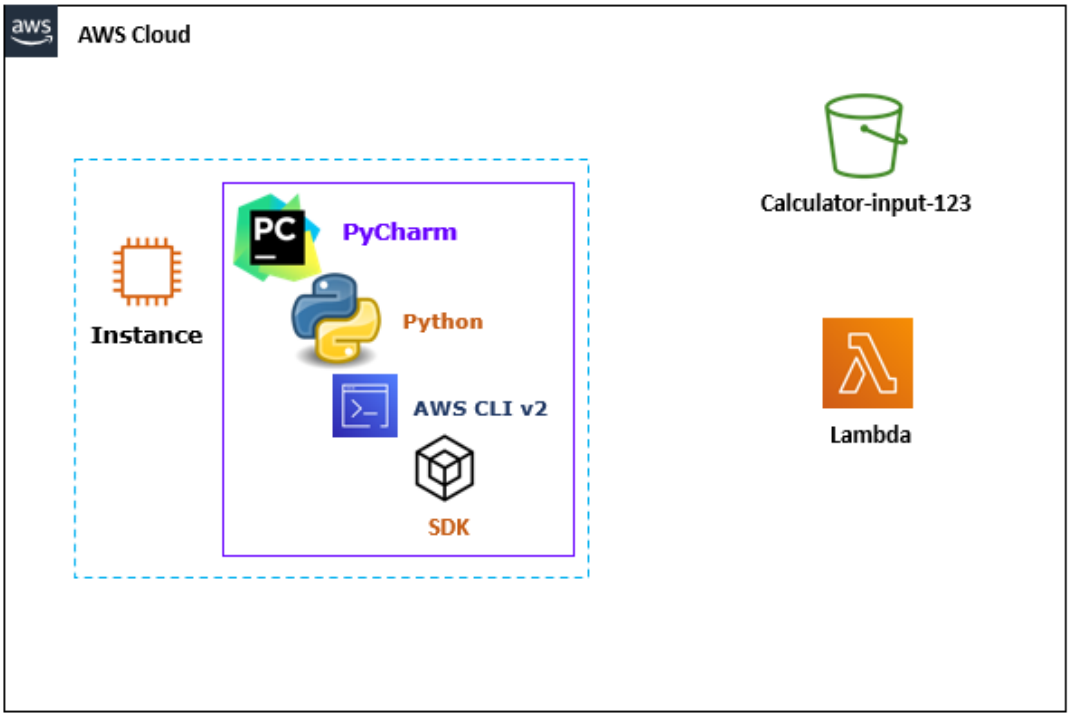
Note: You can see the **numbers.txt** file under Objects.



Task 4: Create Lambda Function

In this task, you will create a Lambda function using the AWS Management Console.

By using this configuration, the Lambda function will be invoked in response to Amazon S3 notifications.



Step 1: Create Lambda Function

23. In the **AWS Management Console**, on the **Services** menu, search and select **Lambda**.

24. Choose the **YOUR ALLOCATED REGION** list to the right of your account information on the navigation bar.

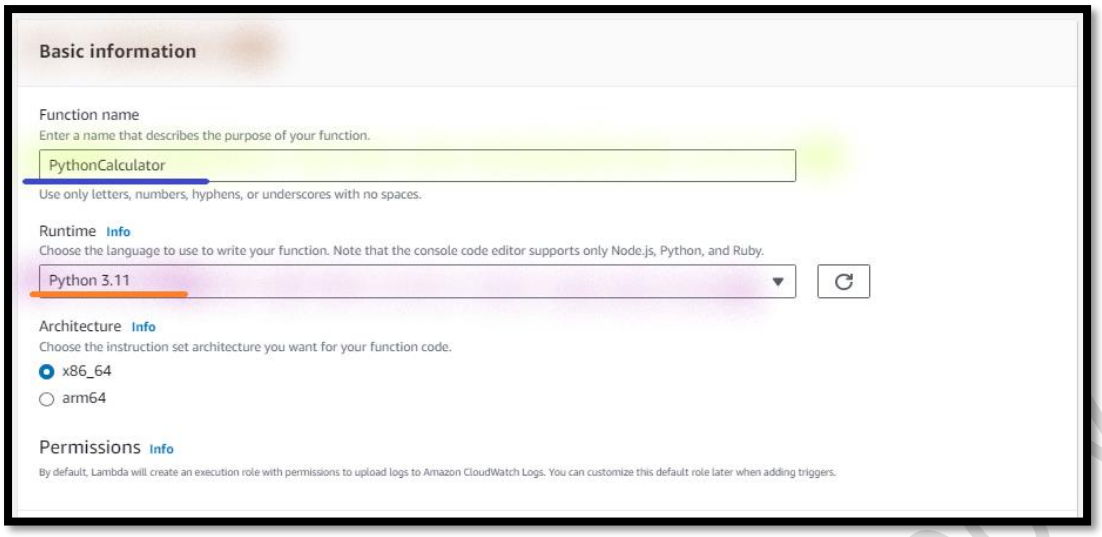
25. Select **Create a function**.

26. Select **Author from scratch** and configure:

    a. In the **Basic Information** section:

        i. **Name**: Write **PythonCalculator**.

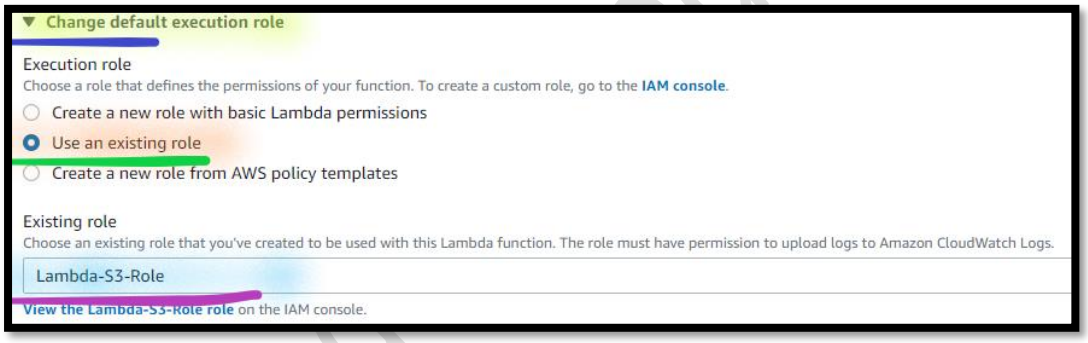
        ii. **Runtime**: Dropdown and select **Python 3.11**.



iii. **Expand** **Change default execution role**.

a) **Execution Role**: Select **Use an existing role**.

1) **Existing role**: Dropdown and select **Lambda-S3-Role**.



b. Select **Create function**.

Note: The lambda function page will be displayed with your function configuration.

Step 2: Configure Lambda Function

27. From the **PythonCalculator** lambda function.

a. In the **Code** section:

i. Select **Runtime settings** sub section:

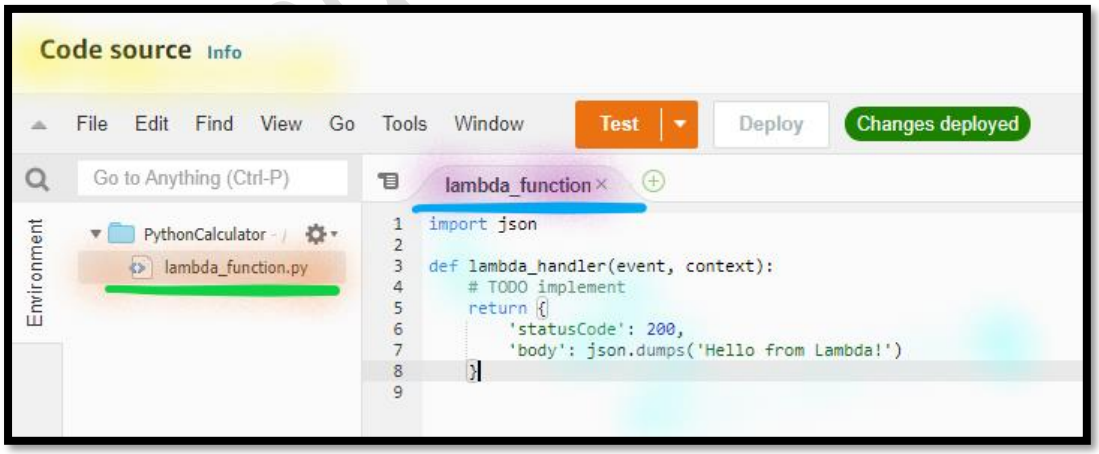
Note: You can see the **Handler** name as **lambda_function.lambda_handler**. If **name is different**, update the name to **lambda_function.lambda_handler**.

Info: Lambda console is **lambda_function.lambda_handler**.
This function **handler name** reflects the function name (**lambda_handler**) and the file where the **handler code** is stored (**lambda_function.py**).

ii. In the **Code source** sub section:

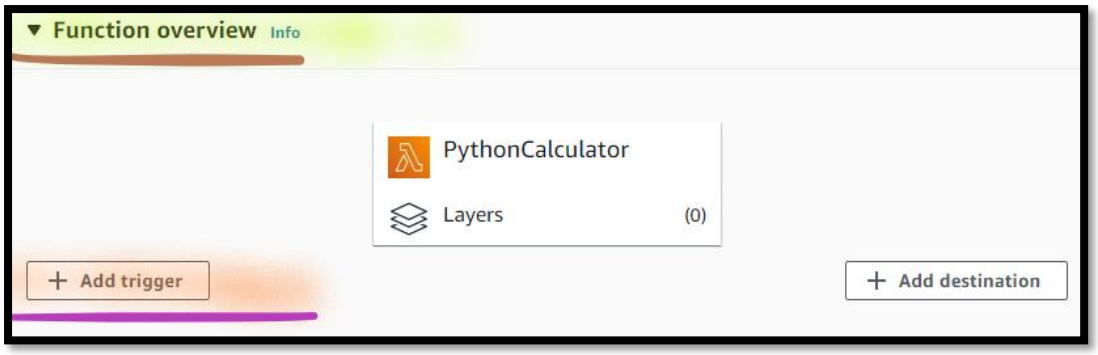
a) **Double-click** on **lambda_function.py**.

Note: You can see the **Default code**.



b. In the **Function overview** section.

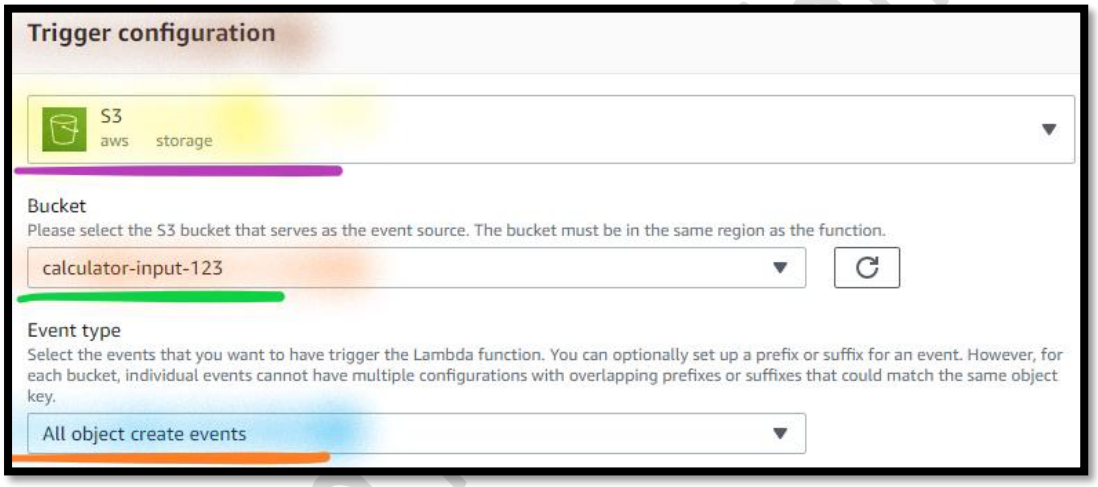
i. Select **+ Add trigger**.



a) **Trigger configuration**: Dropdown and select **S3**.

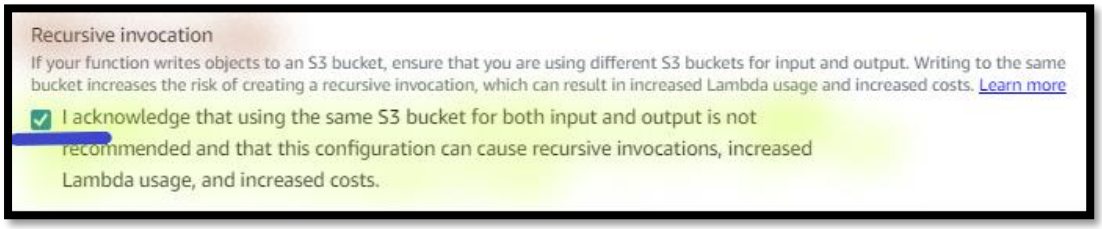
b) **Bucket**: Dropdown and select **calculator-input-123**.

c) **Event type**: Dropdown and select **All object create events**.



Info: For these **trigger settings**, the **lambda function** will **run** whenever an **object** is **created** in your **S3** bucket.

d) **Recursive invocation**: **Enable** *I acknowledge that using the same Amazon S3 bucket …..*



e) Select **Add**.

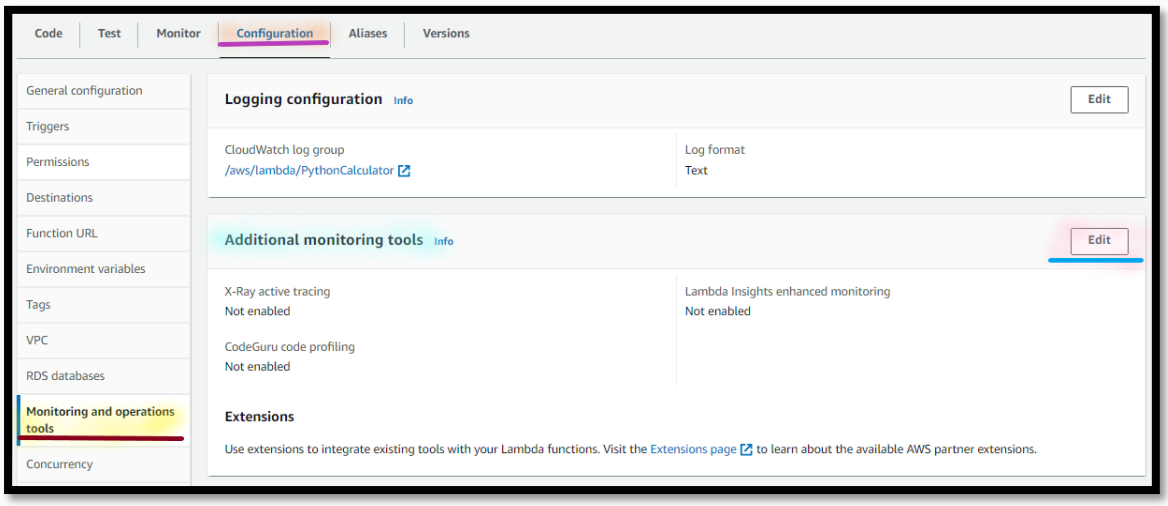
Note: You can see the **message** "**The function is now receiving events from the trigger**".

c. In the **Code** section:

i. Select **Configuration** sub section:

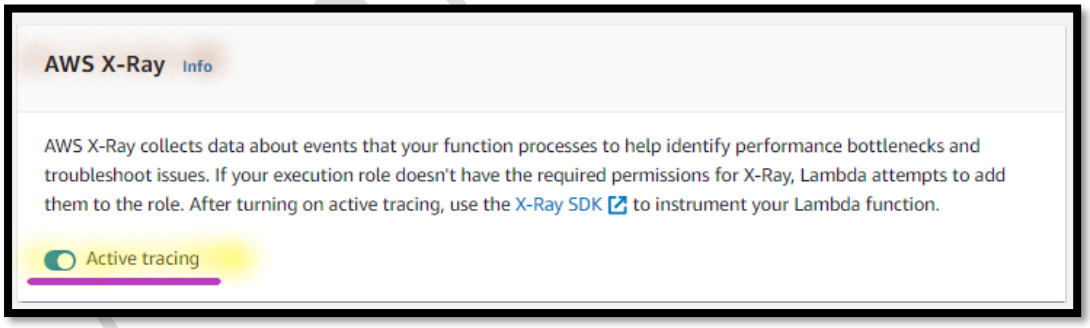
a) Select **Monitoring and operations tools**.

1) **Additional monitoring tool**: Select **Edit**.



I. **AWS X-Ray**:

A. **Active tracing**: **Enable** the same.



b) Select **Save**.

Note: **Go to next Task**, But **Don't Close** the **lambda console**.

Task 5: Developing the Python Application

In this task, you will develop the Python application for Lambda.

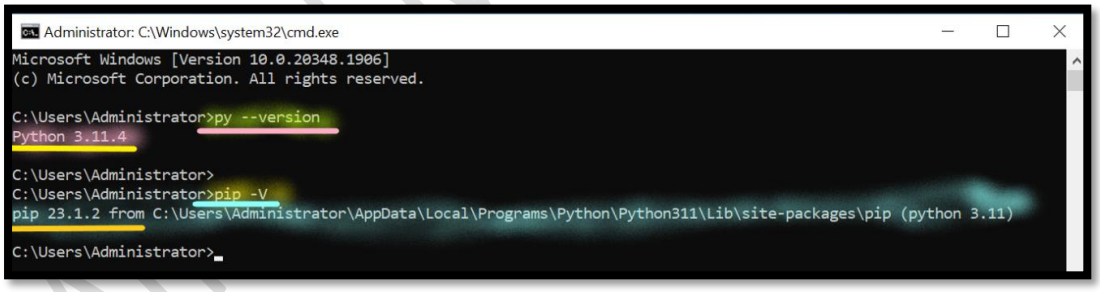
Step 1: Check the Python and PIP Version

28. **Return** to the **DevPYInstance** console.
29. **From** the **DevPYInstance**, right click on **Start** & **Run**.
    a. In the **Open**, write **cmd**.
        i. Press **Ok**.
        ii. From the **command line interpreter**:
            a) Write **py --version**.

Note: You can see the **Python version**.

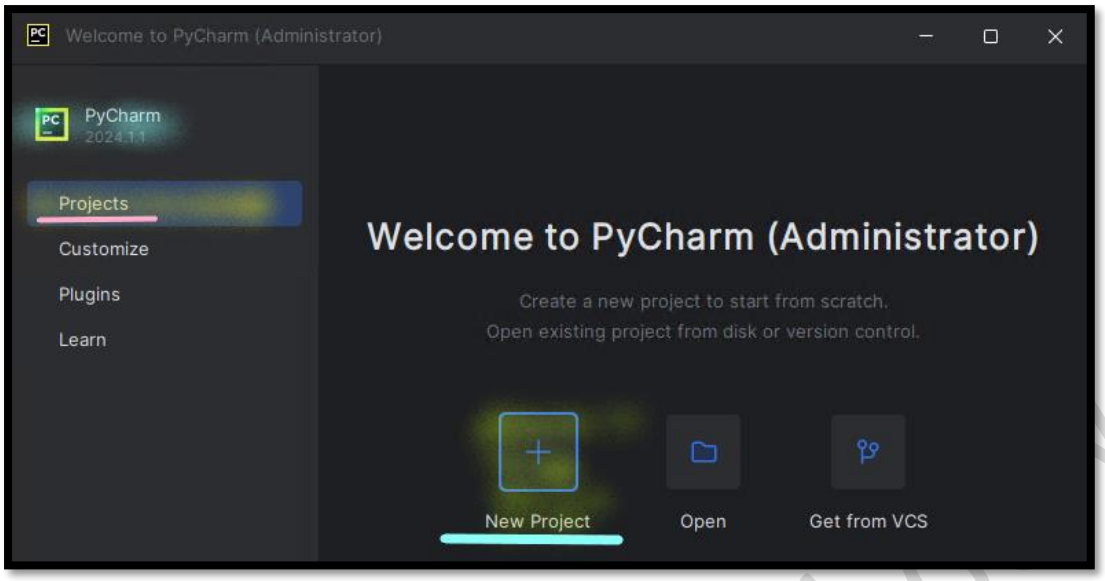
        iii. From the **command line interpreter**:
            a) Write **pip -V**.

Note: You can see the **pip version**.



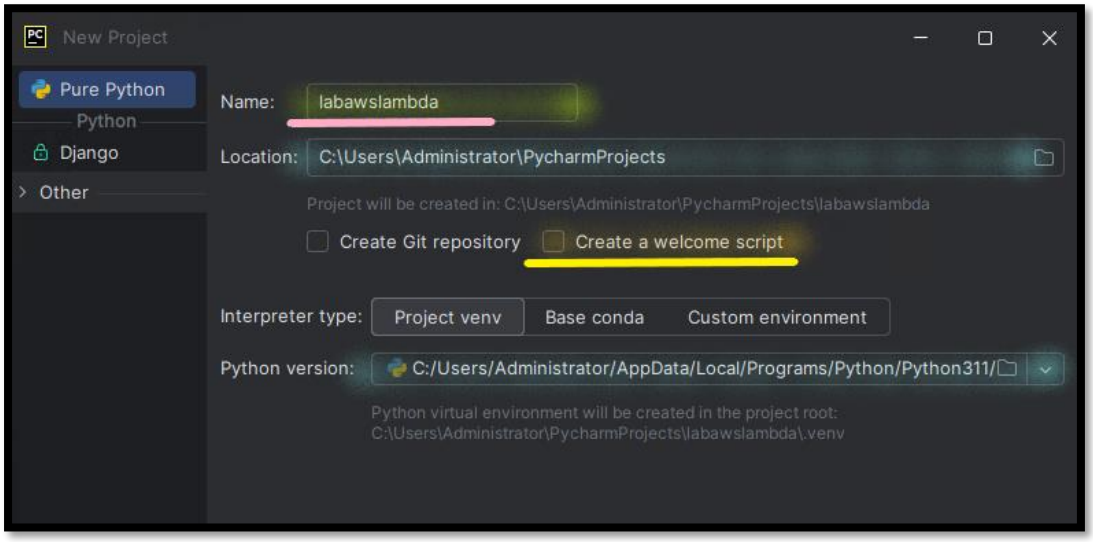
Step 2: Launch the PyCharm IDE

30. From the **DevPYInstance**.
31. Open the **PyCharm IDE**.
    a. In the **PyCharm IDE**:
        i. Select the **New Project**.



a) **Name**: Write **labawslambda**.

b) **Uncheck** the ***Create a welcome script***.



ii. Select **Create**.

Note: **Wait**, till **Virtual environment** gets **created**.

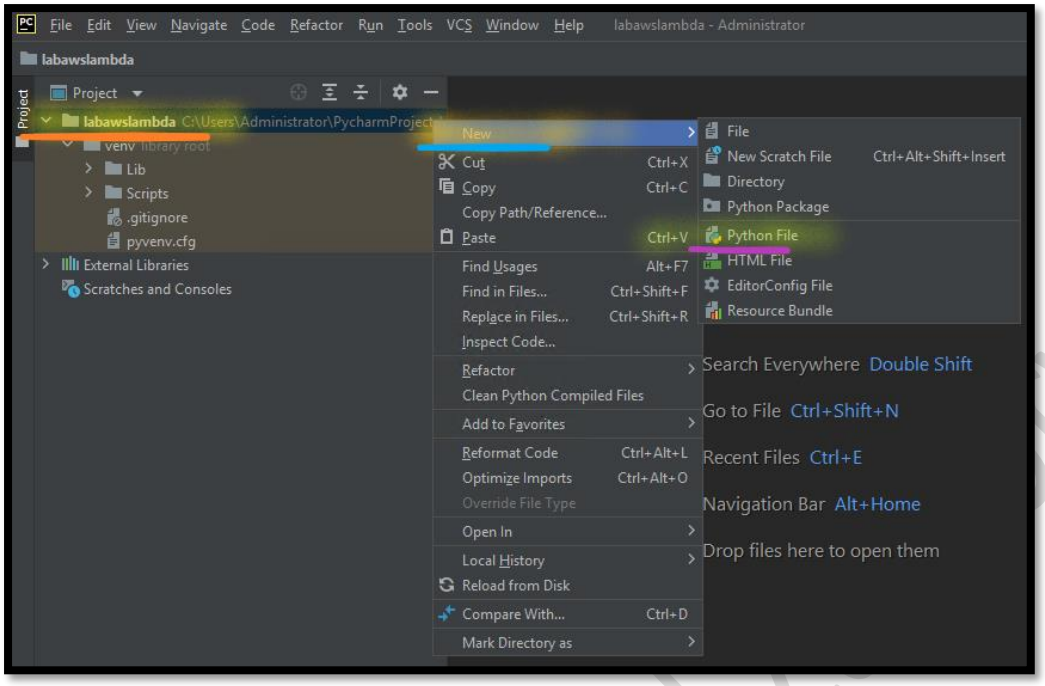
Step 3: Create the File in the Python Project

32. **Expand** the **labawslambda** Python project.

a. **Right-click** on the **labawslambda** Python project.

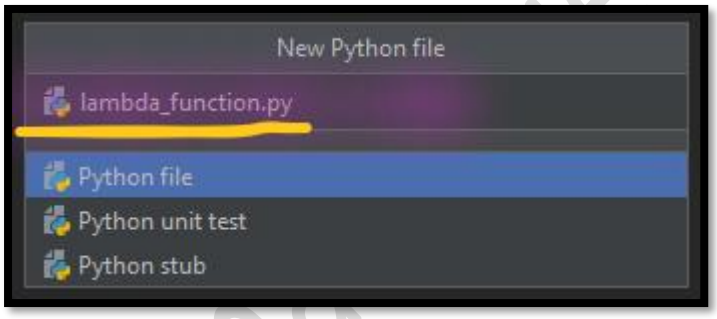
i. Select **New**.

a) Select **Python File**.



b) In the **New python file** page:

1) **File name**: Write **lambda_function.py**.



2) Select **Enter**.

Note: You can see the **lambda_function.py** under Python package.

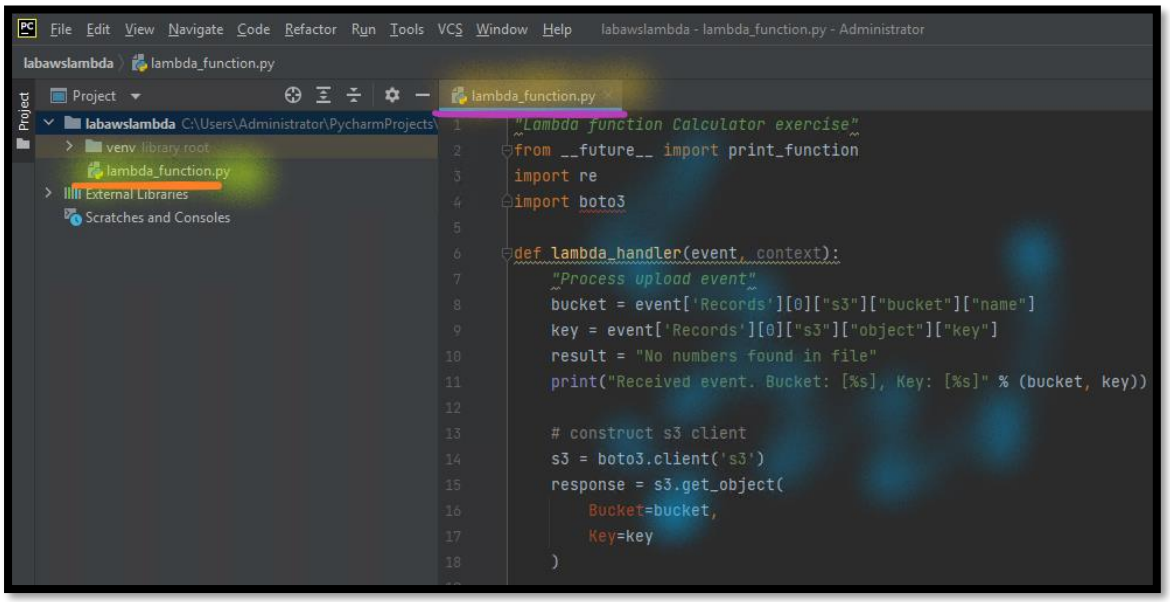
Step 4: Update the Python Code

33. **Double-click** on the **lambda_function.py** Python file.

    a. **Paste** the **Code** from **lambda_function.py** file.

Note: lambda_function.py file is available with **Lab manual**.

Note: Ignore (if) **Python version compatibility** notification.



Info: Take a moment to **familiarize** yourself with the file. The **code** is designed to:

1. **Respond** to an Amazon **S3 bucket event**.
2. **Retrieve** a **file** from Amazon **S3 bucket**.

A regular expression is used to locate all the numbers in the file.

From this array the **code calculates** the **minimum**, **maximum**, and **average** of the numbers. There are statements in a few places in the code.

    b. **From** the **PyCharm IDE**:

        i. Press **CTRL + S**.

Task 6: Build and Test the Lambda function locally

In this task, you will build and test a Lambda function locally. This function retrieves an object from an Amazon S3 bucket, and calculates the minimum, maximum and average of the numbers from the object.

Step 1: Update the Lambda Function

34. **From** the **PyCharm IDE**:

    a. In the **lambda_function.py** file, locate **TODO 1** section:

        i. **Update** the **REPLACE WITH BUCKET NAME** with the **Bucket name**, ***which you have created*** in the previous step.

Note: **Don't remove** the **starting** and **end double quote**.

Note: Object name **numbers.txt** is **already mentioned** in the **TODO 1** section.

    b. **From** the **PyCharm IDE**:

        i. Press **CTRL + S**.

Note: This is a **simulated event** you will use to **test** the **Python code** in **local development**.

Step 2: Install the Python SDK

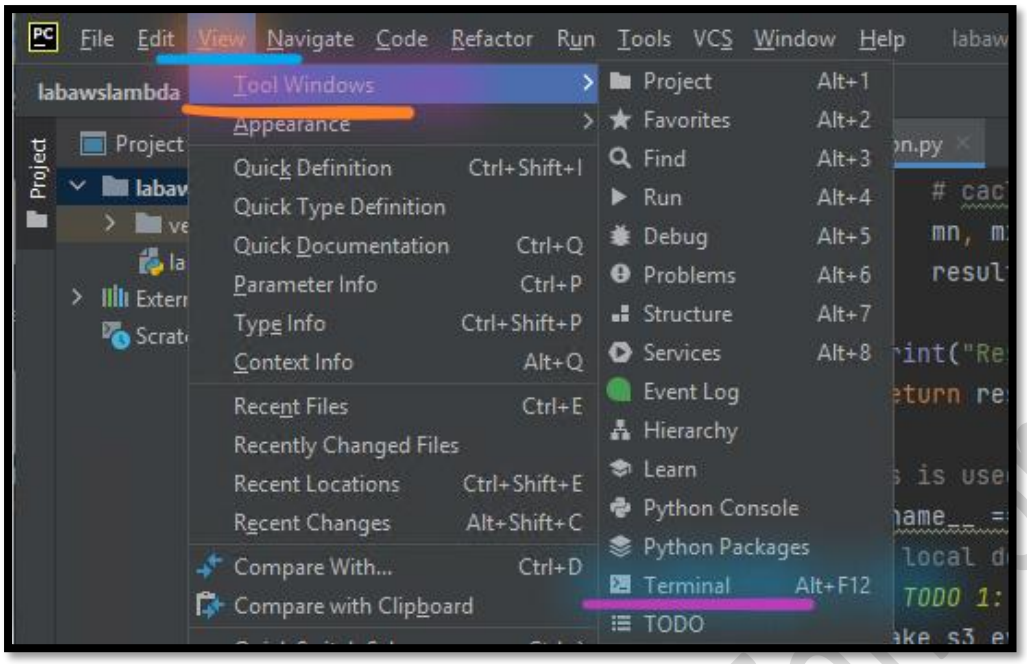
35. **From** the **PyCharm IDE**.

    a. Select **Menu**.

        i. Select **View**.

            a) Select **Tool Windows**.

                1) Select **Terminal**.

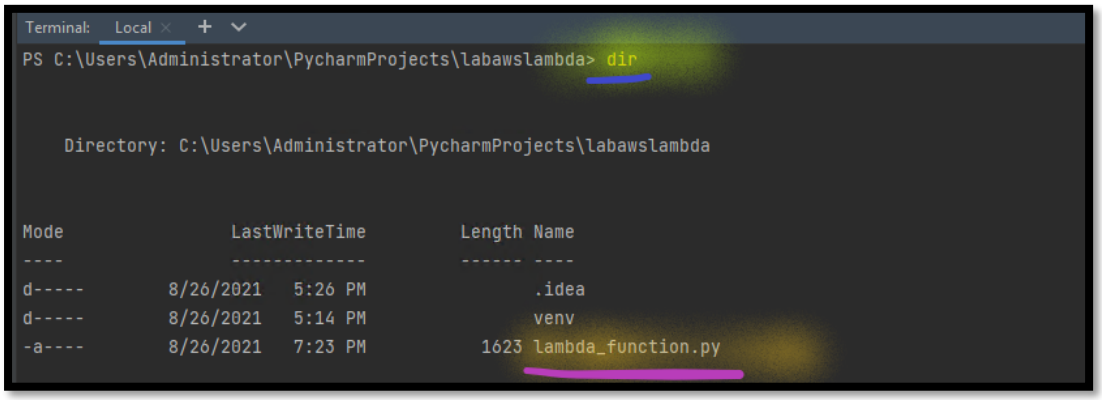


Note: This will **Open** the **Terminal** in your **PyCharm IDE**.

b) From the **Terminal**:

1) **Type** **Dir**.

Note: You can see the **lambda_function.py** file.



c) From the **Terminal**:

1) **Type** **python lambda_function.py** (*to run the Python script*).

Note: You can see the error **'boto3' module not found**.

```
Terminal: Local
PS C:\Users\Administrator\PycharmProjects\labawslambda>
PS C:\Users\Administrator\PycharmProjects\labawslambda> python lambda_function.py
Traceback (most recent call last):
  File "C:\Users\Administrator\PycharmProjects\labawslambda\lambda_function.py", line 4, in <module>
    import boto3
ModuleNotFoundError: No module named 'boto3'
PS C:\Users\Administrator\PycharmProjects\labawslambda>
```

Info: The AWS SDK for Python (Boto3) provides a Python API for AWS services. You use the AWS SDK for Python (Boto3) to create, configure, and manage AWS services.

d) From the **Terminal**:

1) **Type** **pip install boto3**.

```
(venv) C:\Users\Administrator\PycharmProjects>pip install boto3
TODO  Problems  Terminal  Python Packages  Python Console
Indexing completed in 46 sec. Shared indexes were applied to 2,719 of 5,297 files (51%) (15 minutes ago)
```

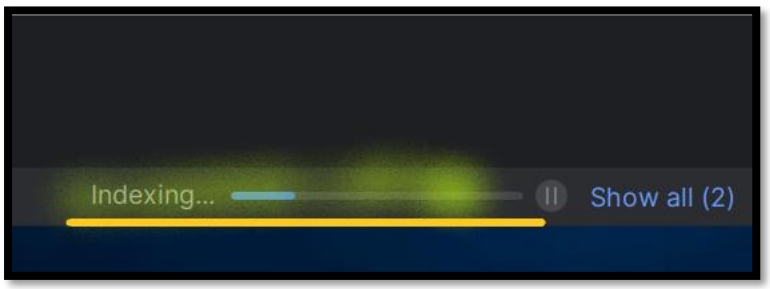
Note: **Wait**, till **boto3** sdk **install** succesfully.

```
Terminal: Local
Collecting python-dateutil<3.0.0,>=2.1
  Downloading python_dateutil-2.8.1-py2.py3-none-any.whl (227 kB)
     |▪▪▪▪▪▪▪▪▪▪▪▪▪▪▪▪▪▪▪▪▪▪▪▪▪▪▪▪▪▪▪▪▪▪| 227 kB ...
Collecting six>=1.5
  Downloading six-1.15.0-py2.py3-none-any.whl (10 kB)
Installing collected packages: six, urllib3, python-dateutil, jmespath, botocore, s3t
Successfully installed boto3-1.17.54 botocore-1.20.54 jmespath-0.10.0 python-dateutil

(venv) C:\Users\Administrator\PycharmProjects>
TODO  Problems  Terminal  Python Packages  Python Console
```

Note: **Ignore** the pip upgrade warnings.

Note: Wait, till **Indexing** gets **completed**.



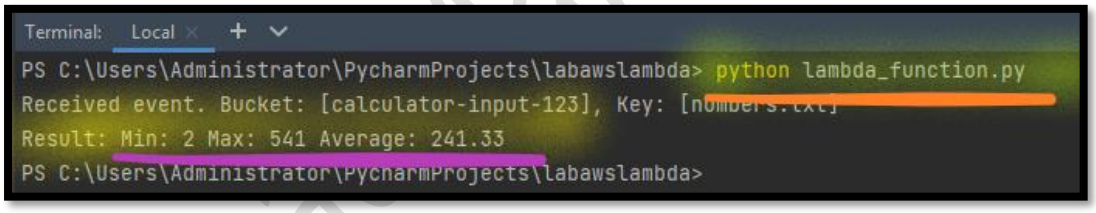
Step 3: Execute the Lambda Function

36. **From** the **PyCharm IDE**.

a) From the **Terminal**:

1) **Type** **python lambda_function.py** (*to run the Python script*).

Note: You can see the **logging output** from the **print statements**.

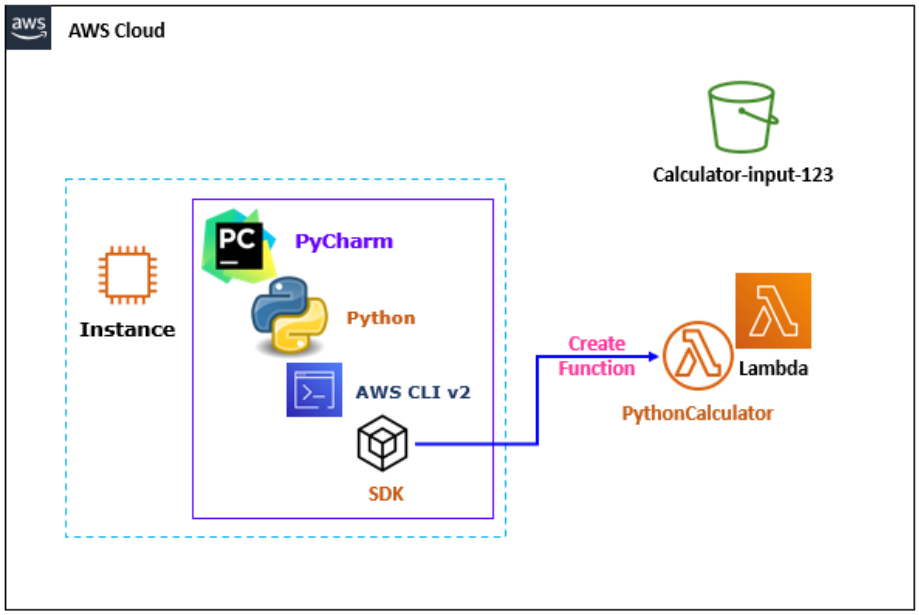


b) From the **Terminal**:

1) **Copy** the **Current working directory path** in **Notepad**.

Task 7: Deploy the Lambda function

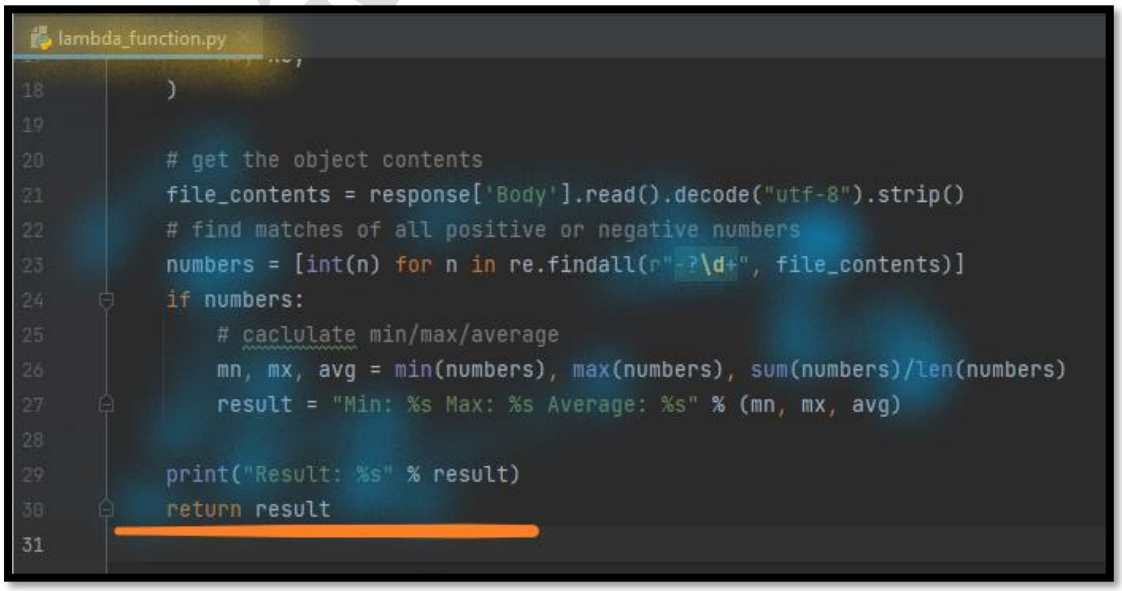
Now that the code has been developed and tested on the Windows Dev Instance, you will deploy your Lambda function.



Step 1: Update the Lambda Function

37. **From** the **PyCharm IDE**.

    a. In the **lambda_function**.py file, locate the **Debugging** **section** and ***remove all the code lines*** from **Row number 32** to the **end**.



b. **From** the **PyCharm IDE**:

i. Press **CTRL + S**.

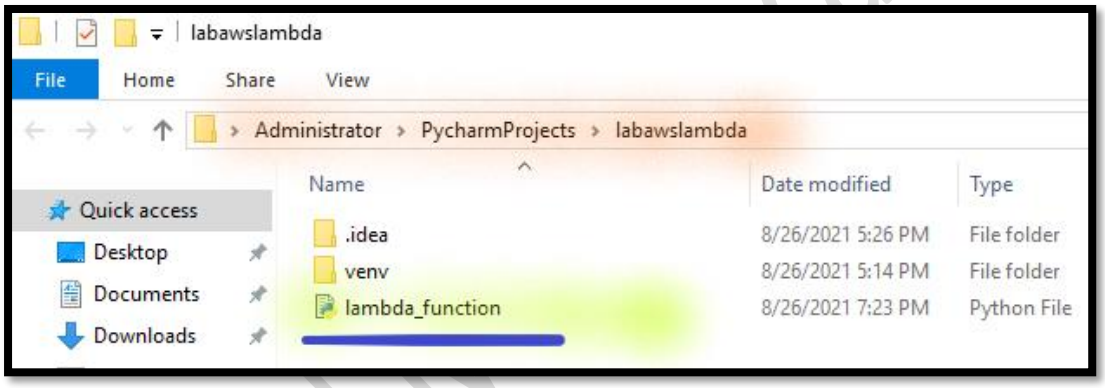
Step 2: Compress the Python Source Code

38. **From** the **DevPYInstance**, right click on **Start** & **Run**.

a. In the **Open**, write **C:\Users\Administrator\PycharmProjects\labawslambda**, Press **Ok**.

Note: Change the **directory path** if you have **different working directory path**.

Note: You can see the **lambda_function.py** file.

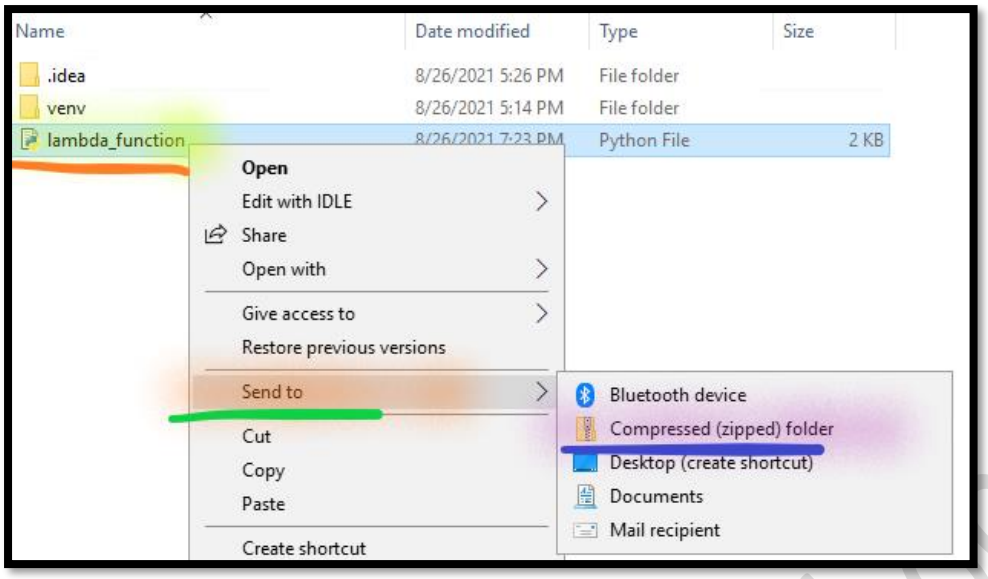


Note: Compress the **lambda_function.py** file.

i. **Right-click** on the **lambda_function.py** file.

a) Select **Send to**.

1) Select **Compressed (zipped) folder**.



Note: Ensure **lambda_function.py** should be in the **root of .Zip file**, not in the sub folder.

Step 3: Deploy the Lambda function from PyCharm

39. **From** the **PyCharm IDE**.

a. From the **Terminal**:

1) **Type Dir**.

Note: You can see the **lambda_function.py** and **lambda_function.zip** file.

b. From the **Terminal**:

1) **Type**
aws lambda update-function-code --function-name PythonCalculator --zip-file fileb://lambda_function.zip

Note: Check the **Output**.

```
Terminal: Local
{
    "FunctionName": "PythonCalculator",
    "FunctionArn": "arn:aws:lambda:us-east-1:504340965905:function:PythonCalculator",
    "Runtime": "python3.8",
    "Role": "arn:aws:iam::504340965905:role/Lambda-S3-Role",
    "Handler": "lambda_function.lambda_handler",
    "CodeSize": 867,
    "Description": "",
    "Timeout": 3,
    "MemorySize": 128,
    "LastModified": "2021-08-26T20:18:00.363+0000",
    "CodeSha256": "teNz3vm4WwZCoPWGJHv9VyGW60kMVebEr8sOQS5DcGQ=",
    "Version": "$LATEST",
    "TracingConfig": {
        "Mode": "PassThrough"
    },
    "RevisionId": "df7b1144-c180-4aa8-937a-e3f15f37840b",
    "State": "Active",
    "LastUpdateStatus": "Successful",
    "PackageType": "Zip"
}
```

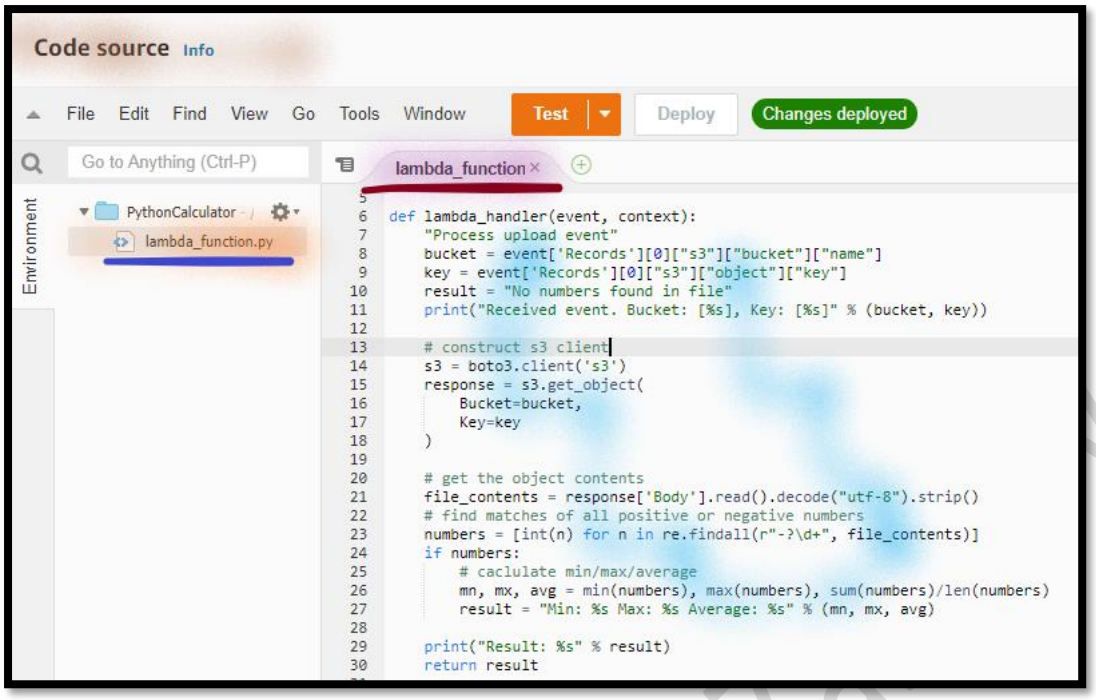
Note: **Go to next Task**, But **Don't Close** the **DevPYInstance console**.

Step 4: Verify the Code from the Lambda Function

40. **Return** to the **Lambda** console.
    a. In the **Code** section.
        i. **Double click** on **lambda_function.py**.

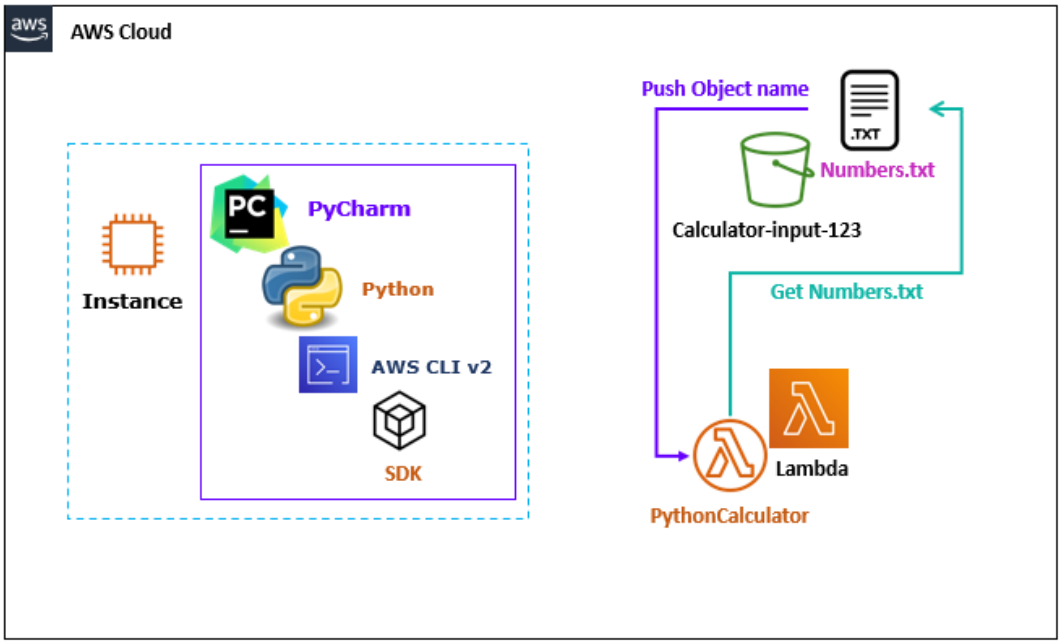
Note: You can see the **Deployed code**.

Note: If you are **not seeing** the **Lambda Code**, **Refresh** your **Browser**.



Task 8: Invoke the Lambda Function

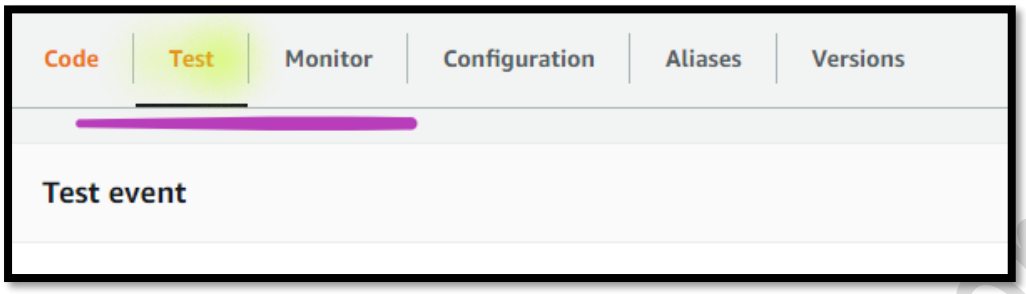
Now that the code has been deployed, invoke the lambda function.



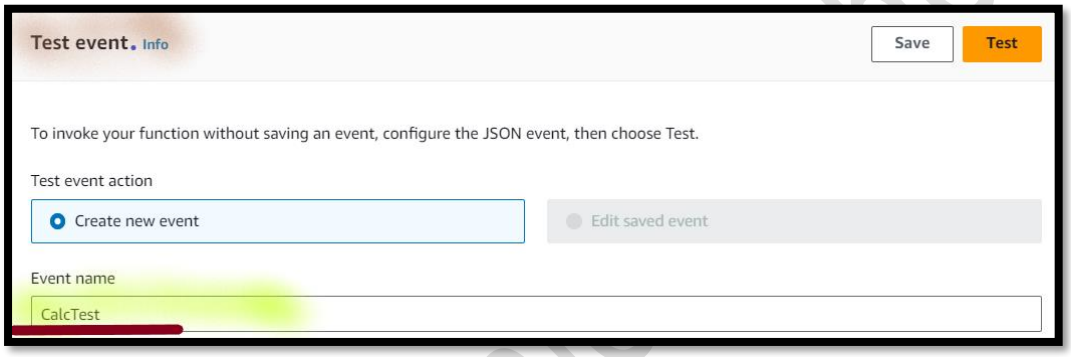
Step 1: Update the Test Events

41. **From** the **Lambda** console.

a. In the **Test** section.



i. **Event Name**: Write **CalcTest**.



ii. In the **Event JSON:**

a) **Remove** the **existing event**.

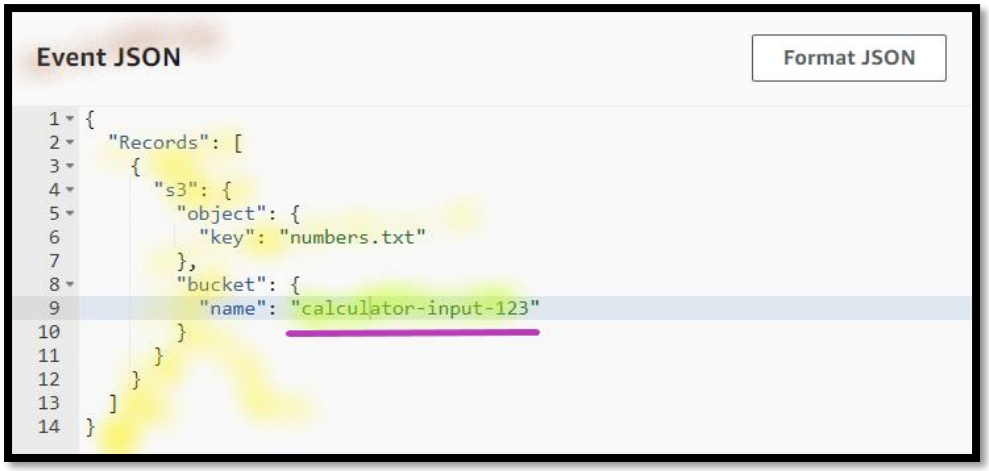
b) **Copy** the **below event**:

```
{
 "Records": [
  {
   "s3": {
    "object": {
     "key": "numbers.txt"
    },
    "bucket": {
     "name": "REPLACE WITH BUCKET NAME"
    }
   }
  }
 ]
}
```

1) **Update** the **REPLACE WITH BUCKET NAME** with the **Bucket name**, ***which you have created*** in the previous step.

Note: Don't remove the **starting** and **end double quote**.

Note: Object name **numbers.txt** is **already mentioned** in the **Test** event.

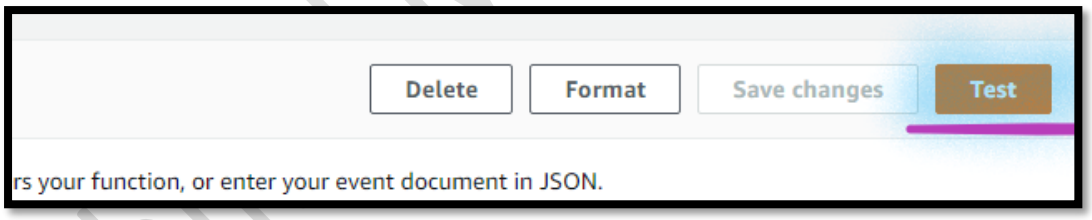


iii. Select **Save**.

Step 2: Validate Your Implementation

42. **From** the **Test** section:

a. Select the **Test**.



Note: Once you **invoked** the **function** and code executed succesfully you can see the **Execution result** as **Succeeded**.

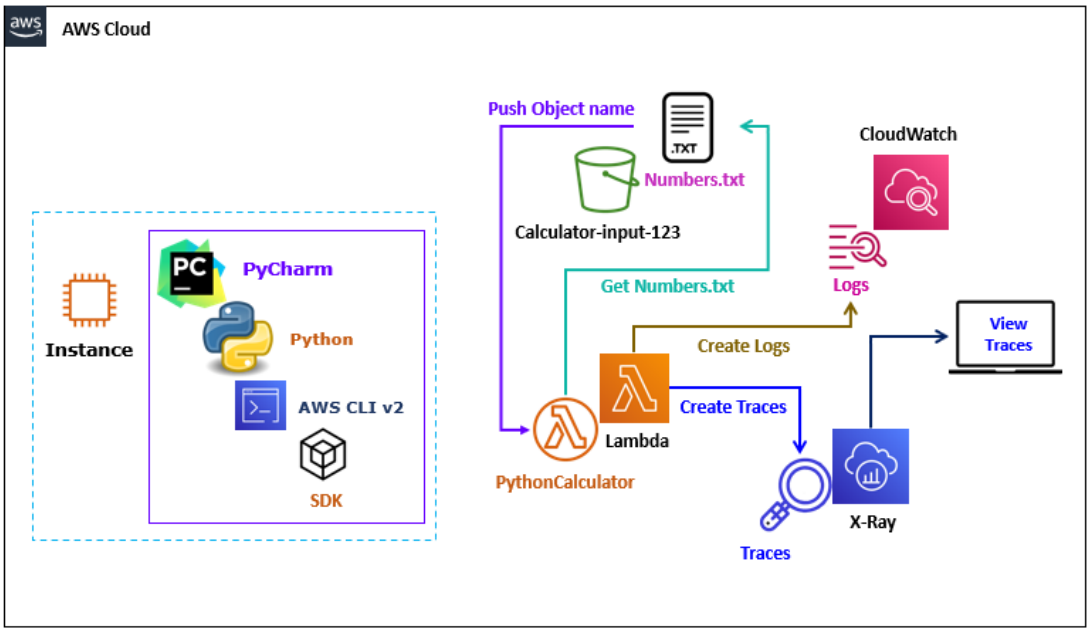
i. **Expand** the **Details** section of the **execution result** section.

Note: You can view the **Min**, **Max** and **Average** count.

Note: **Execute** the **Test multiple times**.

Task 9: Monitor the Lambda Execution

In this task, you will monitor the Events and Traces generated by Lambda.



Step 1: Monitor the CloudWatch Events

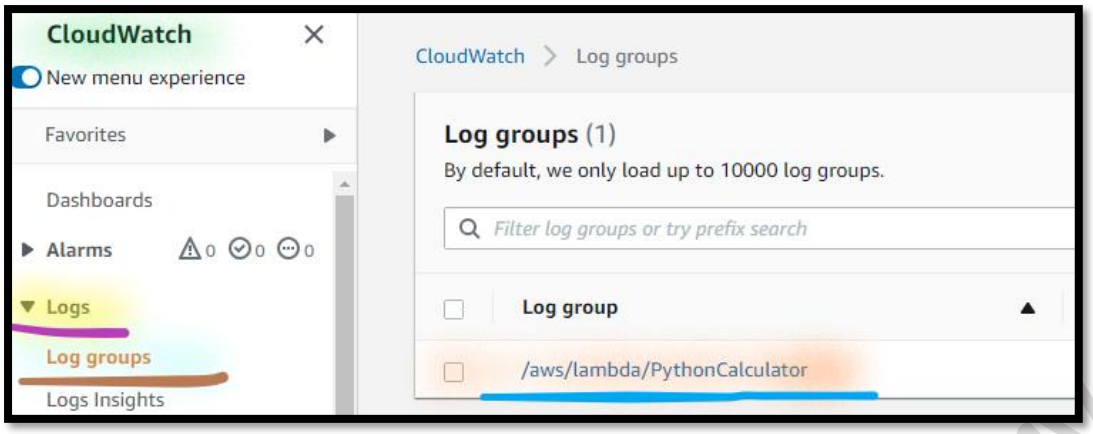
43. In the **AWS Management Console**, on the **Services** menu, search and select **CloudWatch**.

44. Choose the **YOUR ALLOCATED REGION** list to the right of your account information on the navigation bar.

45. **Expand** the **Logs**.

    a. Click on the **Log groups**.

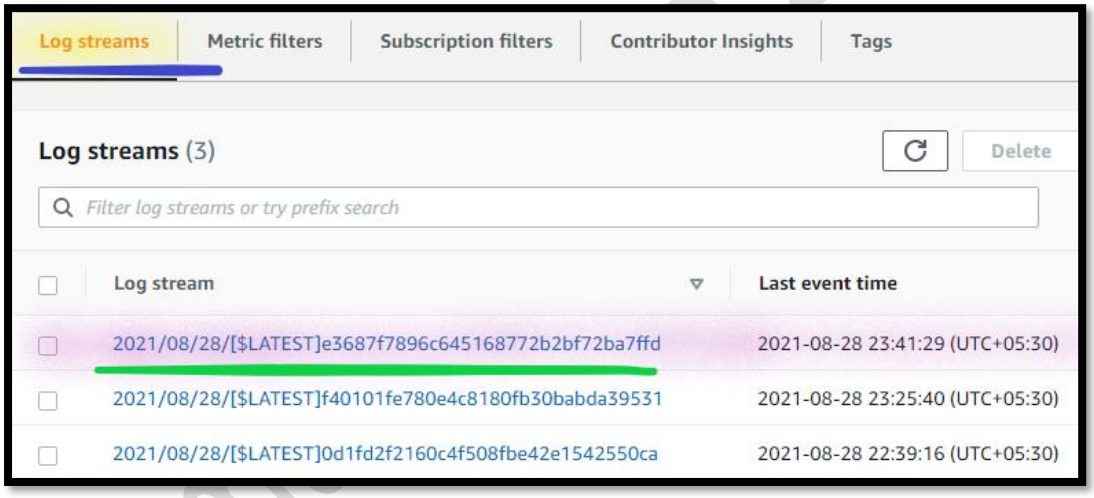
        i. Open the **/aws/lambda/PythonCalculator** log group.



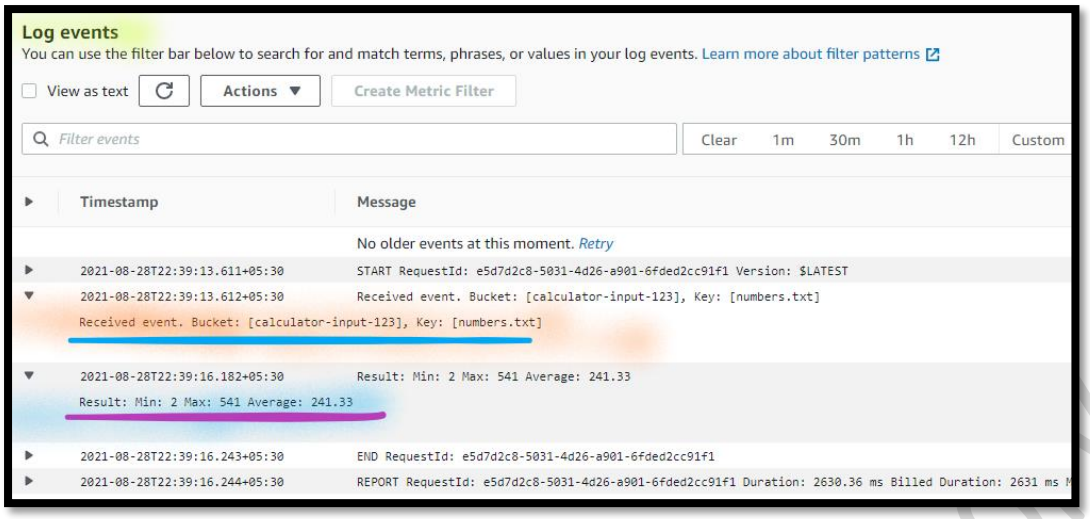
Note: You can see the **Log streams** generated by Lambda with the **Date** and **Time**.

a) Select the **Log streams**.

1) Open the **latest Log streams**.



Note: **Inspect the contents** of all the recent **entries** of all the log streams. Confirm you see the **output** from your **test case** files.



Step 2: Monitor the X-Ray Traces

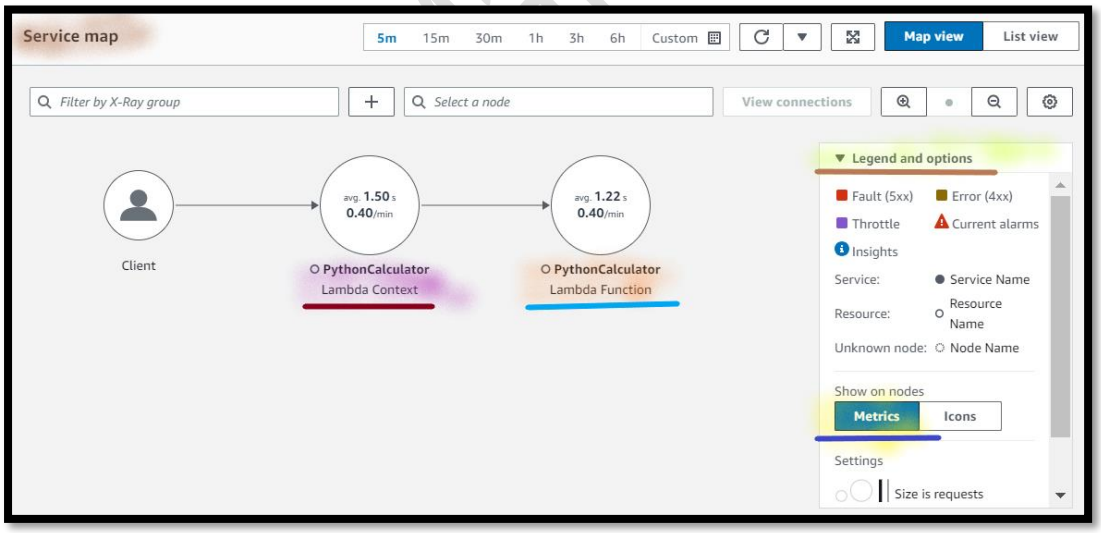
46. **From** the **CloudWatch** console.

    a. Select the **X-Ray traces**.

        i. Select the **Trace map**.

            a) **Expand** **Legend and options**.

                1) Select **Metrics**.



Info:

1. Lambda context: When Lambda runs your function, it **passes a context object to the handler**. This object provides methods and properties that provide information about the invocation, function, and execution environment.

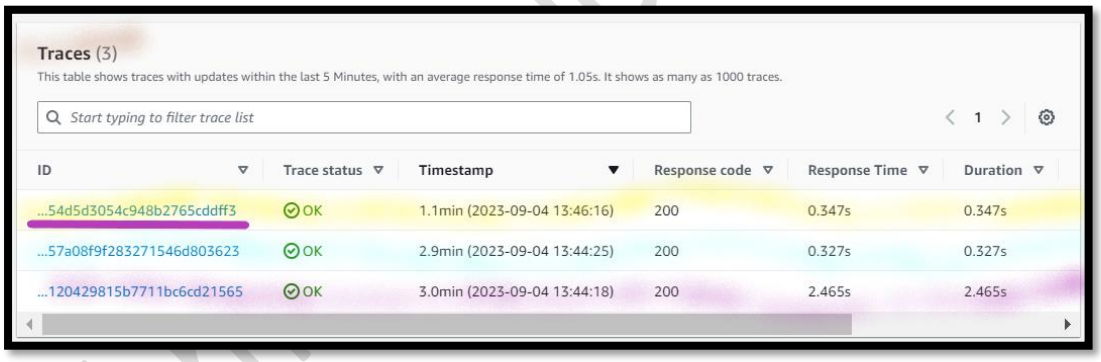
2. Lambda function: The Lambda function handler is the method in your **function code that processes events**. When your function is invoked, Lambda runs the handler method. Your function runs until the handler returns a response, exits, or times out.

47. **From** the **CloudWatch** console.

a. Select the **X-Ray traces**.

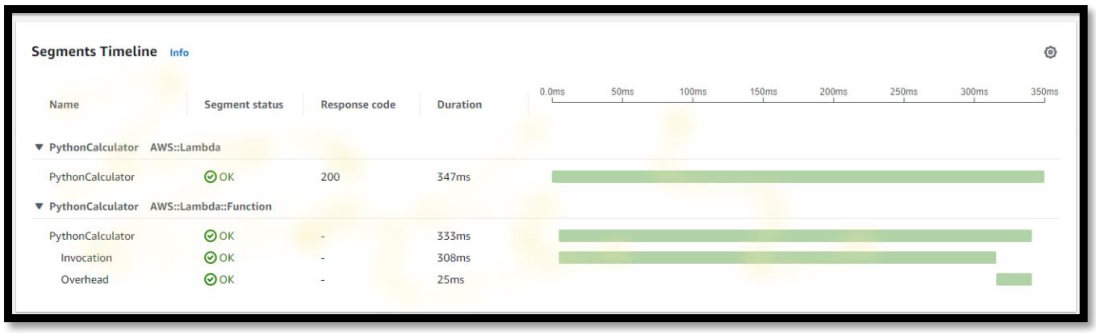
i. Select the **Traces**.

Note: You can view the **Trace IDs**.



i. Open **Any** **Trace ID**.

Note: You can see **Timelines**.



Info: Overhead – commonly called a cold-start, consists of two components.

1. The **first** is the time taken to set up the execution environment for your function's code, which is entirely controlled by AWS.
2. The **second** is the code initialization duration, which is managed by the developer. This is impacted by code outside of the main Lambda handler function and is often responsible for tasks like setting up database connections, initializing objects, downloading reference data, or loading heavy frameworks.

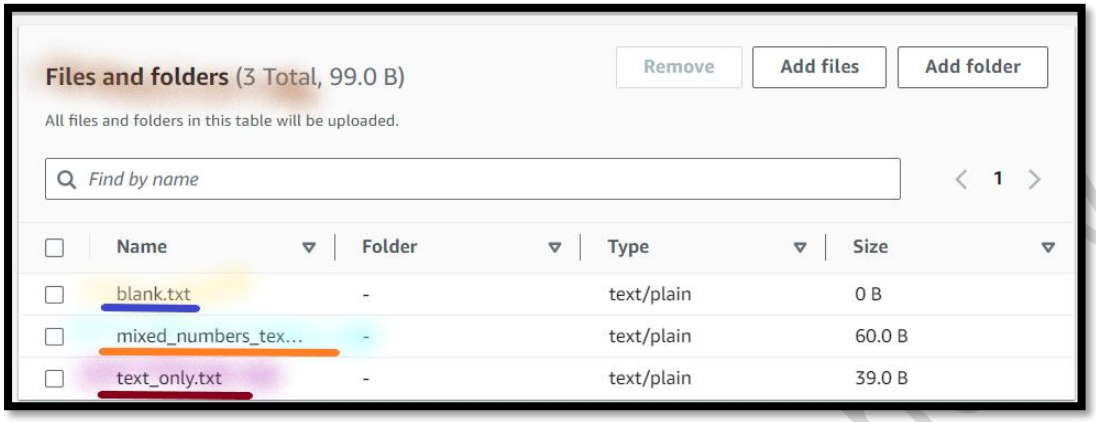
Task 10: Upload Additional Objects

Step 1: Upload Content in the Bucket

48. In the **AWS Management Console**, on the **Services** menu, search and select **S3**.
49. Choose the **YOUR ALLOCATED REGION** list to the right of your account information on the navigation bar.
50. Click the **Buckets**.
51. Open **calculator-input-123** bucket.
    a. Select **Objects**.
        i. Click **Upload**.
            a) Click **Add files**.
                1) **Navigate** and select **blank.txt**, **mixed_numbers_text.txt** and **text_only.txt** file.

I. Select **Open**.

Note: **blank.txt**, **mixed_numbers_text.txt** and **text_only.txt** file is provided with the **Lab manual**.



ii. Select **Upload**.

Note: Once uploaded you can see the **blank.txt**, **mixed_numbers_text.txt** and **text_only.txt** file under **files and folders** section.

Step 2: Monitor the CloudWatch Events

52. In the **AWS Management Console**, on the **Services** menu, search and select **CloudWatch**.

53. Choose the **YOUR ALLOCATED REGION** list to the right of your account information on the navigation bar.

54. Expand the **Logs**.

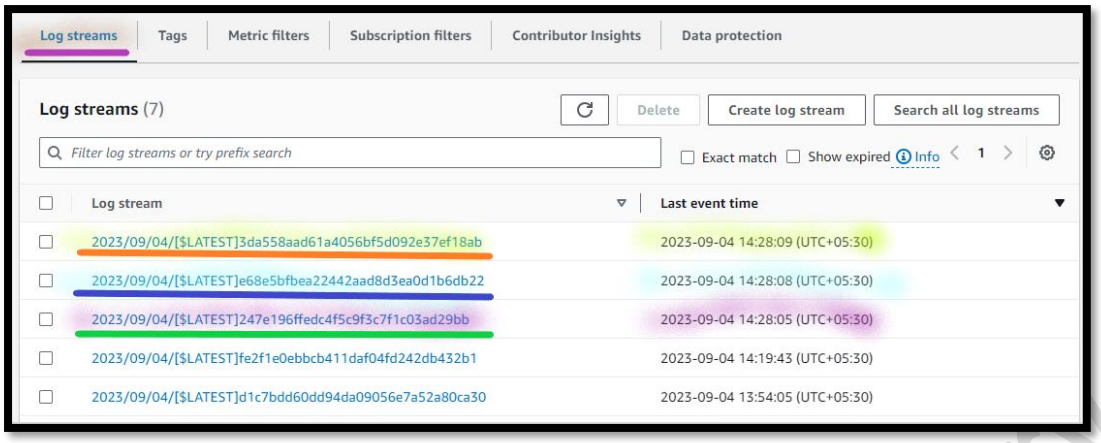
a. Select the **Log groups**.

i. Open the **/aws/lambda/PythonCalculator** log group.

a) Select the **Log streams**.

1) Open the **last three** **latest** **Log streams** (***One by one***).

Note: **Inspect the contents** of all the recent **entries** of all the log streams. Confirm you see the **Output** from your **test case** files.



Task 11: Delete the Environment

Step 1: Close the Project

55. **From** the **PyCharm IDE**.
    a. Select the **Menu**.
        i. Select **File**.
            a) Select **Close project**.

Step 2: Delete the Bucket

56. In the **AWS Management Console**, on the **Services** menu, search and select **S3**.
57. Choose the **YOUR ALLOCATED REGION** list to the right of your account information on the navigation bar.
58. Select the **Buckets**.
    a. Select **calculator-input-123** bucket.
        i. Select **Empty**.
            a) **Type** **permanently delete** to delete all the objects.
            b) Select **Empty**.
            c) Select **Exit**.
    b. Select **calculator-input-123** bucket.
        i. Select **Delete**.
            a) Type **calculator-input-123** bucket name to delete bucket.
            b) Select **Delete bucket**.

Step 3: Delete the Lambda Function

59. In the **AWS Management Console**, on the **Services** menu, search and select **Lambda**.

60. Choose the **YOUR ALLOCATED REGION** list to the right of your account information on the navigation bar.

61. Select the **Functions**.

    a. Select the **PythonCalculator**.

        i. Select **Actions**.

            a) Select **Delete**.

                1) When you ***get prompt***, write **delete**.

                I. Select **Delete**.

                A. Select **Close**.

Step 4: Delete the Log Groups

62. In the **AWS Management Console**, on the **Services** menu, click **CloudWatch**.

63. Choose the **YOUR ALLOCATED REGION** list to the right of your account information on the navigation bar.

64. Expand the **Logs**.

    a. Select the **Log groups**.

        i. Select **/aws/lambda/PythonCalculator**.

            a) Select **Actions**.

                1) Select **Delete log groups(s)**.

                I. Select **Delete**.