Dash Components

Skills Network

Objectives

After completing the lab you will be able to:

- Know how to add multiple graphs to the dashboard
- Work with Dash Callbacks to handle multiple outputs

Estimated time needed: 30 minutes

Dataset Used

[Airline Reporting Carrier On-Time Performance](#) dataset from [Data Asset eXchange](#)

About Skills Network Cloud IDE

This Skills Network Labs Cloud IDE (Integrated Development Environment) provides a hands-on environment in your web browser for completing course and project related labs. It utilizes Theia, an open-source IDE platform, that can be run on desktop or on the cloud.
So far in the course you have been using Jupyter notebooks to run your python code. This IDE provides an alternative for editing and running your Python code. In this lab you will be using this alternative Python runtime to create and launch your Dash applications.

Important Notice about this lab environment

Please be aware that sessions for this lab environment are not persisted. When you launch the Cloud IDE, you are presented with a 'dedicated computer on the cloud' exclusively for you. This is available to you as long as you are actively working on the labs.

Once you close your session or it is timed out due to inactivity, you are logged off, and this 'dedicated computer on the cloud' is deleted along with any files you may have created, dowloaded or installed. The next time you launch this lab, a new environment is created for you.

If you finish only part of the lab and return later, you may have to start from the beginning. So, it is a good idea to plan to your time accordingly and finish your labs in a single session.

Let's start creating dash application

Theme

Analyze flight delays in a dashboard.

Dashboard Components

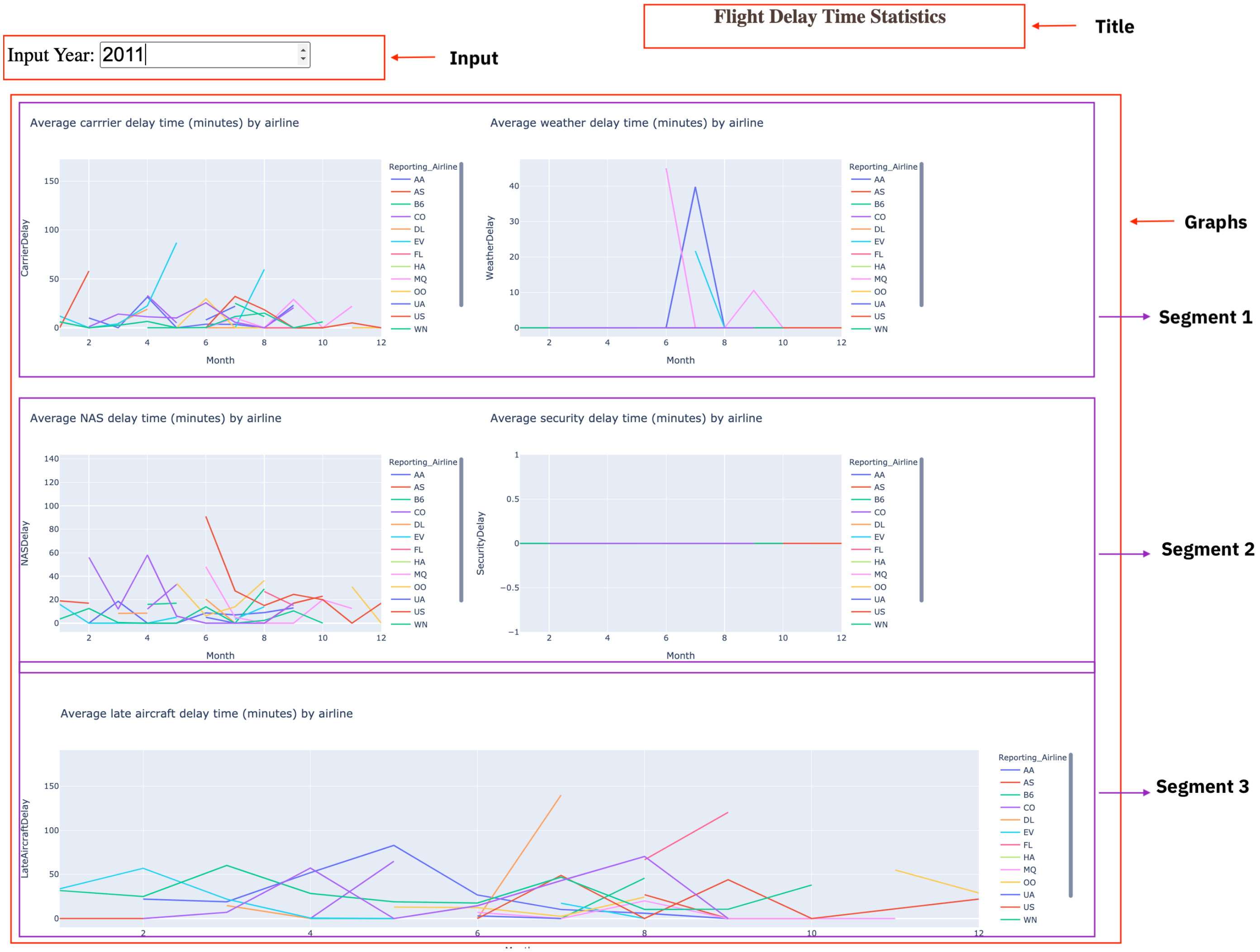
- Monthly average carrier delay by reporting airline for the given year.
- Monthly average weather delay by reporting airline for the given year.
- Monthly average national air system delay by reporting airline for the given year.
- Monthly average security delay by reporting airline for the given year.
- Monthly average late aircraft delay by reporting airline for the given year.

NOTE: Year range should be between 2010 and 2020

Expected Output

Below is the expected result from the lab. Our dashboard application consists of three components:

- Title of the application
- Component to enter input year
- 5 Charts conveying the different types of flight delay. Chart section is divided into three segments.
  - Carrier and Weather delay in the first segment
  - National air system and Security delay in the second segment
  - Late aircraft delay in the third segment



Flight Delay Time Statistics

Input Year: 2011

Title
Input
Graphs
Segment 1
Segment 2
Segment 3
Average carrrier delay time (minutes) by airline
CarrierDelay
150
100
50
0
2
4
6
8
10
12
Month
Average weather delay time (minutes) by airline
WeatherDelay
40
30
20
10
0
Average NAS delay time (minutes) by airline
NASDelay
140
120
100
80
60
40
20
Average security delay time (minutes) by airline
SecurityDelay
1
0.5
−0.5
−1
Average late aircraft delay time (minutes) by airline
LateAircraftDelay
Reporting_Airline
AA
AS
B6
CO
DL
EV
FL
HA
MQ
OO
UA
US
WN

To do:

- Design layout for the application.
- Create a callback function. Add callback decorator, define inputs and outputs.
- Review the helper function that performs computation on the provided inputs.
- Create 5 line graphs.
- Run the application.

Get the tool ready

- Install python packages required to run the application. Copy and paste the below command to the terminal.

```
1. 1
```

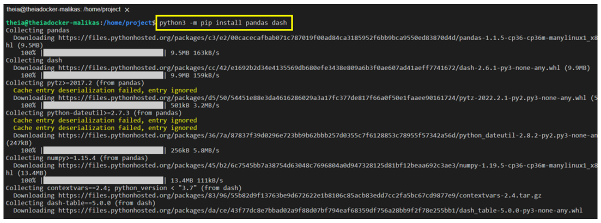
1. python3 -m pip install packaging

Copied!

1. 1

1. python3 -m pip install pandas dash

Copied!



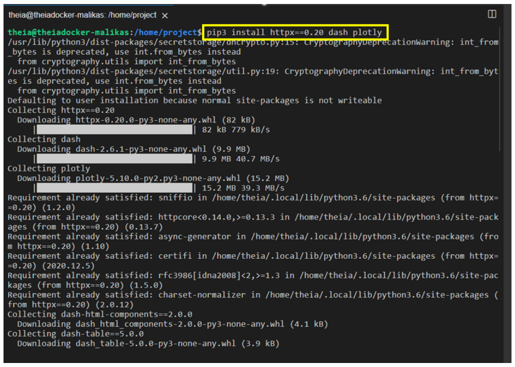
```
theia@theiadocker-malikas: /home/project ×

theia@theiadocker-malikas:/home/project$ python3 -m pip install pandas dash
Collecting pandas
  Downloading https://files.pythonhosted.org/packages/c3/e2/00cacecafbab071c787019f00ad84ca3185952f6bb9bca9550ed83870d4d/pandas-1.1.5-cp36-cp36m-manylinux1_x8
hl (9.5MB)
    100% |████████████████████████████████| 9.5MB 163kB/s
Collecting dash
  Downloading https://files.pythonhosted.org/packages/cc/42/e1692b2d34e4135569db680efe3438e809a6b3f0ae607ad41aeff7741672/dash-2.6.1-py3-none-any.whl (9.9MB)
    100% |████████████████████████████████| 9.9MB 159kB/s
Collecting pytz>=2017.2 (from pandas)
  Cache entry deserialization failed, entry ignored
  Downloading https://files.pythonhosted.org/packages/d5/50/54451e88e3da4616286029a3a17fc377de817f66a0f50e1faaee90161724/pytz-2022.2.1-py2.py3-none-any.whl (5
    100% |████████████████████████████████| 501kB 3.2MB/s
Collecting python-dateutil>=2.7.3 (from pandas)
  Cache entry deserialization failed, entry ignored
  Cache entry deserialization failed, entry ignored
  Downloading https://files.pythonhosted.org/packages/36/7a/87837f39d0296e723bb9b62bbb257d0355c7f6128853c78955f57342a56d/python_dateutil-2.8.2-py2.py3-none-an
(247kB)
    100% |████████████████████████████████| 256kB 5.8MB/s
Collecting numpy>=1.15.4 (from pandas)
  Downloading https://files.pythonhosted.org/packages/45/b2/6c7545bb7a38754d63048c7696804a0d947328125d81bf12beaa692c3ae3/numpy-1.19.5-cp36-cp36m-manylinux1_x8
hl (13.4MB)
    100% |████████████████████████████████| 13.4MB 111kB/s
Collecting contextvars==2.4; python_version < "3.7" (from dash)
  Downloading https://files.pythonhosted.org/packages/83/96/55b82d9f13763be9d672622e1b8106c85acb83edd7cc2fa5bc67cd9877e9/contextvars-2.4.tar.gz
Collecting dash-table==5.0.0 (from dash)
  Downloading https://files.pythonhosted.org/packages/da/ce/43f77dc8e7bbad02a9f88d07bf794eaf68359df756a28bb9f2f78e255bb1/dash_table-5.0.0-py3-none-any.whl
```

1. 1

1. pip3 install httpx==0.20 dash plotly

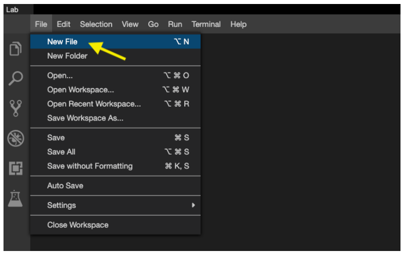
Copied!



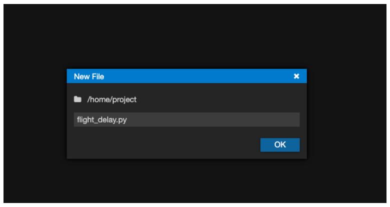
```
theia@theiadocker-malikas: /home/project ×

theia@theiadocker-malikas:/home/project$ pip3 install httpx==0.20 dash plotly
/usr/lib/python3/dist-packages/secretstorage/dhcrypto.py:15: CryptographyDeprecationWarning: int_from
_bytes is deprecated, use int.from_bytes instead
  from cryptography.utils import int_from_bytes
/usr/lib/python3/dist-packages/secretstorage/util.py:19: CryptographyDeprecationWarning: int_from_byt
es is deprecated, use int.from_bytes instead
  from cryptography.utils import int_from_bytes
Defaulting to user installation because normal site-packages is not writeable
Collecting httpx==0.20
  Downloading httpx-0.20.0-py3-none-any.whl (82 kB)
     |████████████████████████████████| 82 kB 779 kB/s
Collecting dash
  Downloading dash-2.6.1-py3-none-any.whl (9.9 MB)
     |████████████████████████████████| 9.9 MB 40.7 MB/s
Collecting plotly
  Downloading plotly-5.10.0-py2.py3-none-any.whl (15.2 MB)
     |████████████████████████████████| 15.2 MB 39.3 MB/s
Requirement already satisfied: sniffio in /home/theia/.local/lib/python3.6/site-packages (from httpx=
=0.20) (1.2.0)
Requirement already satisfied: httpcore<0.14.0,>=0.13.3 in /home/theia/.local/lib/python3.6/site-pack
ages (from httpx==0.20) (0.13.7)
Requirement already satisfied: async-generator in /home/theia/.local/lib/python3.6/site-packages (fro
m httpx==0.20) (1.10)
Requirement already satisfied: certifi in /home/theia/.local/lib/python3.6/site-packages (from httpx=
=0.20) (2020.12.5)
Requirement already satisfied: rfc3986[idna2008]<2,>=1.3 in /home/theia/.local/lib/python3.6/site-pac
kages (from httpx==0.20) (1.5.0)
Requirement already satisfied: charset-normalizer in /home/theia/.local/lib/python3.6/site-packages (
from httpx==0.20) (2.0.12)
Collecting dash-html-components==2.0.0
  Downloading dash_html_components-2.0.0-py3-none-any.whl (4.1 kB)
Collecting dash-table==5.0.0
  Downloading dash_table-5.0.0-py3-none-any.whl (3.9 kB)
```

- Create a new python script, by clicking on the menu bar and selecting **File**->**New File**, as in the image below.

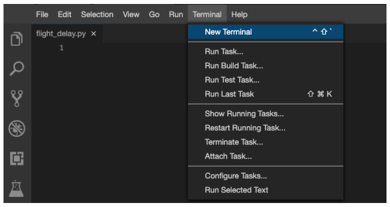


- Provide the file name as `flight_details.py`

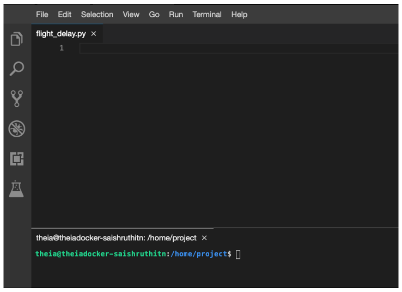


flight_delay.py

- Open a new terminal, by clicking on the menu bar and selecting **Terminal**->**New Terminal**, as in the image below.



- Now, you have script and terminal ready to start the lab.



```
theia@theiadocker-saishruthitn:/home/project$
```

TASK 1 - Read the data

Let's start with

- Importing necessary libraries
- Reading the data

Copy the below code to the `flight_delay.py` script and review the code.

```
1. 1
2. 2
3. 3
4. 4
```

```
# Import required libraries
import pandas as pd
import plotly.graph_objects as go
import dash
import dash_html_components as html
import dash_core_components as dcc
from dash.dependencies import Input, Output
import plotly.express as px

# Read the airline data into pandas dataframe
airline_data =  pd.read_csv('https://cf-courses-data.s3.us.cloud-object-storage.appdomain.cloud/IBMDeveloperSkillsNetwork-DV0101EN-SkillsNetwork/Data%20Files/airline_data.csv',
                            encoding = "ISO-8859-1",
                            dtype={'Div1Airport': str, 'Div1TailNum': str,
                                   'Div2Airport': str, 'Div2TailNum': str})
```

Copied!

TASK 2 - Create dash application and get the layout skeleton

Next, we create a skeleton for our dash application. Our dashboard application layout has three components as seen before:

- Title of the application
- Component to enter input year inside a layout division
- 5 Charts conveying the different types of flight delay

Mapping to the respective Dash HTML tags:

- Title added using `html.H1()` tag
- Layout division added using `html.Div()` and input component added using `dcc.Input()` tag inside the layout division.
- 5 charts split into three segments. Each segment has a layout division added using `html.Div()` and chart added using `dcc.Graph()` tag inside the layout division.

Copy the below code to the `flight_delay.py` script and review the structure.

NOTE: Copy below the current code

```
# Create a dash application
app = dash.Dash(__name__)

# Build dash app layout
app.layout = html.Div(children=[ html.H1(),
                                html.Div(["Input Year: ", dcc.Input()],
                                style={'font-size': 30}),
                                html.Br(),
                                html.Br(),
                                html.Div([
                                        html.Div(),
                                        html.Div()
                                ], style={'display': 'flex'}),

                                html.Div([
                                        html.Div(),
                                        html.Div()
                                ], style={'display': 'flex'}),

                                html.Div(, style={'width':'65%'})
                                ])
```

Copied!

NOTE: We are using display as `flex` for two outer divisions to get graphs side by side in a row.

TASK 3 - Update layout components

Application title

- Title as `Flight Delay Time Statistics`, align text as `center`, color as `#503D36`, and font size as `30`.

Input component

- Update dcc.Input component `id` as `input-year`, default `value` as `2010`, and `type` as `number`. Use `style` parameter and assign height of the input box to be `35px` and font-size to be `30`.

Output component - Segment 1

Segment 1 is the first `html.Div()`. We have two inner division where first two graphs will be placed.

Skeleton

```
html.Div([
          html.Div(),
          html.Div()
         ], style={'display': 'flex'}),
```

Copied!

First inner division

- Add `dcc.Graph()` component.
- Update dcc.Graph component `id` as `carrier-plot`.

Second inner division

- Add `dcc.Graph()` component.
- Update dcc.Graph component `id` as `weather-plot`.

Output component - Segment 2

Segment 2 is the second `html.Div()`. We have two inner division where the next two graphs will be placed.

Skeleon

```
html.Div([
          html.Div(),
          html.Div()
         ], style={'display': 'flex'}),
```

Copied!

First inner division

- Add `dcc.Graph()` component.
- Update dcc.Graph component `id` as `nas-plot`.

Second inner division

- Add `dcc.Graph()` component.
- Update dcc.Graph component `id` as `security-plot`.

Output component - Segment 3

Segment 3 is the last `html.Div()`.

Skeleon

```
html.Div(, style={'width':'65%'})
```

Copied!

- Add `dcc.Graph()` component to the first inner division.
- Update dcc.Graph component `id` as `late-plot`.

TASK 4 - Review and add supporting function

Below is the function that gets input year and data, perform computation for creating charts and plots.

Copy the below code to the `flight_delay.py` script and review the structure.

NOTE: Copy below the current code

```
""" Compute_info function description

This function takes in airline data and selected year as an input and performs computation for creating charts and plots.

Arguments:
    airline_data: Input airline data.
    entered_year: Input year for which computation needs to be performed.

Returns:
    Computed average dataframes for carrier delay, weather delay, NAS delay, security delay, and late aircraft delay.

"""
def compute_info(airline_data, entered_year):
    # Select data
    df =  airline_data[airline_data['Year']==int(entered_year)]
    # Compute delay averages
    avg_car = df.groupby(['Month','Reporting_Airline'])['CarrierDelay'].mean().reset_index()
    avg_weather = df.groupby(['Month','Reporting_Airline'])['WeatherDelay'].mean().reset_index()
    avg_NAS = df.groupby(['Month','Reporting_Airline'])['NASDelay'].mean().reset_index()
    avg_sec = df.groupby(['Month','Reporting_Airline'])['SecurityDelay'].mean().reset_index()
    avg_late = df.groupby(['Month','Reporting_Airline'])['LateAircraftDelay'].mean().reset_index()
    return avg_car, avg_weather, avg_NAS, avg_sec, avg_late
```

Copied!

TASK 5 - Add the application callback function

The core idea of this application is to get year as user input and update the dashboard in real-time. We will be using `callback` function for the same.

Steps:

- Define the callback decorator
- Define the callback function that uses the input provided to perform the computation
- Create graph and return it as an output
- Run the application

Copy the below code to the `flight_delay.py` script and review the structure.

NOTE: Copy below the current code

```
# Callback decorator
@app.callback( [
               Output(component_id='carrier-plot', component_property='figure'),
               ---
               ---
               ---
               ---
               ],
               Input(....))
# Computation to callback function and return graph
def get_graph(entered_year):

    # Compute required information for creating graph from the data
    avg_car, avg_weather, avg_NAS, avg_sec, avg_late = compute_info(airline_data, entered_year)

    # Line plot for carrier delay
    carrier_fig = px.line(avg_car, x='Month', y='CarrierDelay', color='Reporting_Airline', title='Average carrier delay time (minutes) by airline')
    # Line plot for weather delay
    weather_fig = ------
    # Line plot for nas delay
    nas_fig = ------
    # Line plot for security delay
    sec_fig = ------
    # Line plot for late aircraft delay
    late_fig = ------

    return[carrier_fig, weather_fig, nas_fig, sec_fig, late_fig]

# Run the app
if __name__ == '__main__':
    app.run_server()
```

Copied!

TASK 6 - Update the callback function

Callback decorator

- Refer examples provided here
- We have 5 output components added in a list. Update output component id parameter with the ids provided in the `dcc.Graph()` component and set the component property as `figure`. One sample has been added to the skeleton.
- Update input component id parameter with the id provided in the `dcc.Input()` component and component property as `value`.

Callback function

Next is to update the `get_graph` function. We have already added a function `compute_info` that will perform computation on the data using the input.

Mapping the returned value from the function `compute_info` to graph:

- `avg_car` - input for carrier delay
- `avg_weather` - input for weather delay
- `avg_NAS` - input for NAS delay
- `avg_sec` - input for security delay
- `avg_late` - input for late aircraft delay

Code has been provided for plotting carrier delay. Follow the same process and use the above mapping to get plots for other 4 delays.

Refer to the full code of `4.8_Flight_Delay_Time_Statistics_Dashboard.py`

```
# Import required libraries
import pandas as pd
import dash
import dash_html_components as html
import dash_core_components as dcc
from dash.dependencies import Input, Output
import plotly.express as px

# Read the airline data into pandas dataframe
airline_data =  pd.read_csv('https://cf-courses-data.s3.us.cloud-object-storage.appdomain.cloud/IBMDeveloperSkillsNetwork-DV0101EN-SkillsNetwork/Data%20Files/airline_data.csv',
                            encoding = "ISO-8859-1",
                            dtype={'Div1Airport': str, 'Div1TailNum': str,
                                   'Div2Airport': str, 'Div2TailNum': str})

# Create a dash application
app = dash.Dash(__name__)

# Build dash app layout
app.layout = html.Div(children=[ html.H1('Flight Delay Time Statistics',
                                style={'textAlign': 'center', 'color': '#503D36',
                                'font-size': 30}),
                                html.Div(["Input Year: ", dcc.Input(id='input-year', value='2010',
                                type='number', style={'height':'35px', 'font-size': 30}),],
                                style={'font-size': 30}),
                                html.Br(),
                                html.Br(),
                                # Segment 1
                                html.Div([
                                        html.Div(dcc.Graph(id='carrier-plot')),
                                        html.Div(dcc.Graph(id='weather-plot'))
                                ], style={'display': 'flex'}),
                                # Segment 2
                                html.Div([
                                        html.Div(dcc.Graph(id='nas-plot')),
                                        html.Div(dcc.Graph(id='security-plot'))
                                ], style={'display': 'flex'}),
                                # Segment 3
                                html.Div(dcc.Graph(id='late-plot'), style={'width':'65%'})
                                ])

""" Compute_info function description

This function takes in airline data and selected year as an input and performs computation for creating charts and plots.

Arguments:
    airline_data: Input airline data.
    entered_year: Input year for which computation needs to be performed.

Returns:
    Computed average dataframes for carrier delay, weather delay, NAS delay, security delay, and late aircraft delay.

"""
def compute_info(airline_data, entered_year):
    # Select data
    df =  airline_data[airline_data['Year']==int(entered_year)]
    # Compute delay averages
    avg_car = df.groupby(['Month','Reporting_Airline'])['CarrierDelay'].mean().reset_index()
    avg_weather = df.groupby(['Month','Reporting_Airline'])['WeatherDelay'].mean().reset_index()
    avg_NAS = df.groupby(['Month','Reporting_Airline'])['NASDelay'].mean().reset_index()
    avg_sec = df.groupby(['Month','Reporting_Airline'])['SecurityDelay'].mean().reset_index()
    avg_late = df.groupby(['Month','Reporting_Airline'])['LateAircraftDelay'].mean().reset_index()
    return avg_car, avg_weather, avg_NAS, avg_sec, avg_late

"""Callback Function

Function that returns fugures using the provided input year.

Arguments:

    entered_year: Input year provided by the user.

Returns:

    List of figures computed using the provided helper function `compute_info`.
"""
# Callback decorator
@app.callback( [
               Output(component_id='carrier-plot', component_property='figure'),
               Output(component_id='weather-plot', component_property='figure'),
               Output(component_id='nas-plot', component_property='figure'),
               Output(component_id='security-plot', component_property='figure'),
               Output(component_id='late-plot', component_property='figure')
               ],
               Input(component_id='input-year', component_property='value'))
# Computation to callback function and return graph
def get_graph(entered_year):

    # Compute required information for creating graph from the data
    avg_car, avg_weather, avg_NAS, avg_sec, avg_late = compute_info(airline_data, entered_year)

    # Line plot for carrier delay
    carrier_fig = px.line(avg_car, x='Month', y='CarrierDelay', color='Reporting_Airline', title='Average carrrier delay time (minutes) by airline')
    # Line plot for weather delay
    weather_fig = px.line(avg_weather, x='Month', y='WeatherDelay', color='Reporting_Airline', title='Average weather delay time (minutes) by airline')
    # Line plot for nas delay
    nas_fig = px.line(avg_NAS, x='Month', y='NASDelay', color='Reporting_Airline', title='Average NAS delay time (minutes) by airline')
    # Line plot for security delay
    sec_fig = px.line(avg_sec, x='Month', y='SecurityDelay', color='Reporting_Airline', title='Average security delay time (minutes) by airline')
    # Line plot for late aircraft delay
    late_fig = px.line(avg_late, x='Month', y='LateAircraftDelay', color='Reporting_Airline', title='Average late aircraft delay time (minutes) by airline')

    return[carrier_fig, weather_fig, nas_fig, sec_fig, late_fig]

# Run the app
if __name__ == '__main__':
    app.run_server()
```

Copied!

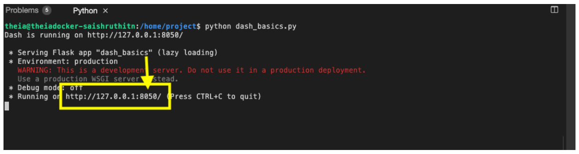
TASK 6 - Run the application

- Copy and paste the below command in the terminal to run the application.

```
python3 flight_delay.py
```

Copied!

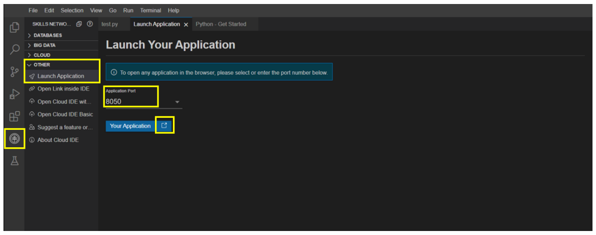
- Observe the port number shown in the terminal.



```
theia@theiadocker-saishruthitn:/home/project$ python dash_basics.py
Dash is running on http://127.0.0.1:8050/

 * Serving Flask app "dash_basics" (lazy loading)
 * Environment: production
   WARNING: This is a development server. Do not use it in a production deployment.
   Use a production WSGI server instead.
 * Debug mode: off
 * Running on http://127.0.0.1:8050/ (Press CTRL+C to quit)
```

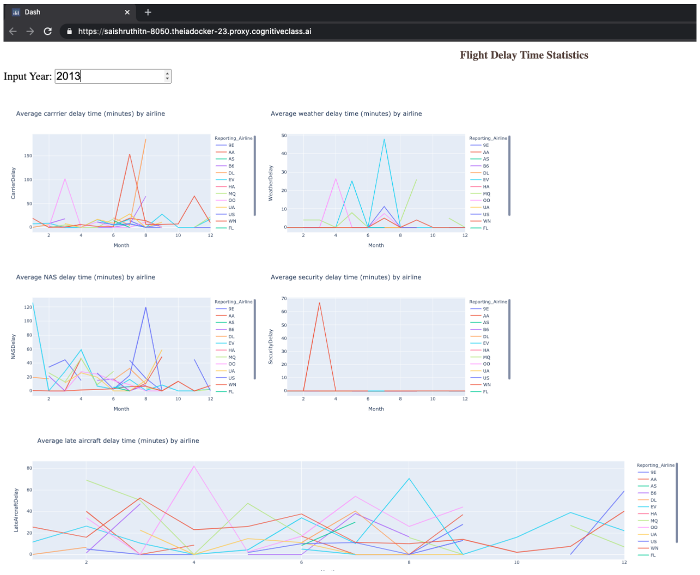
- Click on the `Launch Application` option from the side menu bar. Provide the port number and click `OK`



To open any application in the browser, please select or enter the port number below.

Application Port: 8050

The app will open in a new browser tab like below:


Dash
https://saishruthitn-8050.theiadocker-23.proxy.cognitiveclass.ai

Flight Delay Time Statistics

Input Year: 2013

Average carrrier delay time (minutes) by airline
CarrierDelay
Month
Average weather delay time (minutes) by airline
WeatherDelay
Month
Average NAS delay time (minutes) by airline
NASDelay
Month
Average security delay time (minutes) by airline
SecurityDelay
Month
Average late aircraft delay time (minutes) by airline
LateAircraftDelay
Reporting_Airline
9E
AA
AS
B6
DL
EV
HA
MQ
OO
UA
US
WN
FL

Congratulations, you have successfully created your dash application!

Exercise : Practice Tasks

You will practice some tasks to update the dashboard.

1. Change the title to the dashboard from `"Flight Delay Time Statistics"` to `"Flight Details Statistics Dashboard"` using HTML H1 component and font-size as 35.

- ► Answer

2. Save the above changes and rename file as `flight_details.py`and relaunch the dashboard application to see the updated dashboard title.

- ► Answer

3. Write a command to stop the running app in the terminal

- ► Answer

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Changelog

Date	Version	Changed by	Change Description
05-07-2021	1.0	Saishruthi	Initial version created
24-08-2022	1.1	Pratiksha	Updated Instructions
29-08-2022	1.2	Pratiksha Verma	Updated Screenshot