Azure Notebooks is a cloud-based platform for building and running Jupyter notebooks. Jupyter is an environment based on IPython that facilitates interactive programming and data analysis using a variety of programming languages, including Python. Jupyter notebooks enjoy widespread use in research and academia for mathematical modeling, machine learning, statistical analysis, and for teaching and learning how to code.

Azure Notebooks provide Jupyter as a service for free. It's a convenient way to build notebooks and share them with others without having to install and manage a Jupyter server. And it's web-based, making it an ideal solution for collaborating online. In this lab, you will create an Azure Notebook and use three popular Python libraries — scikit-learn, NumPy, and Seaborn — to analyze climate data collected by NASA. Then you will share the notebook so others can experiment with it, too.

Learning objectives

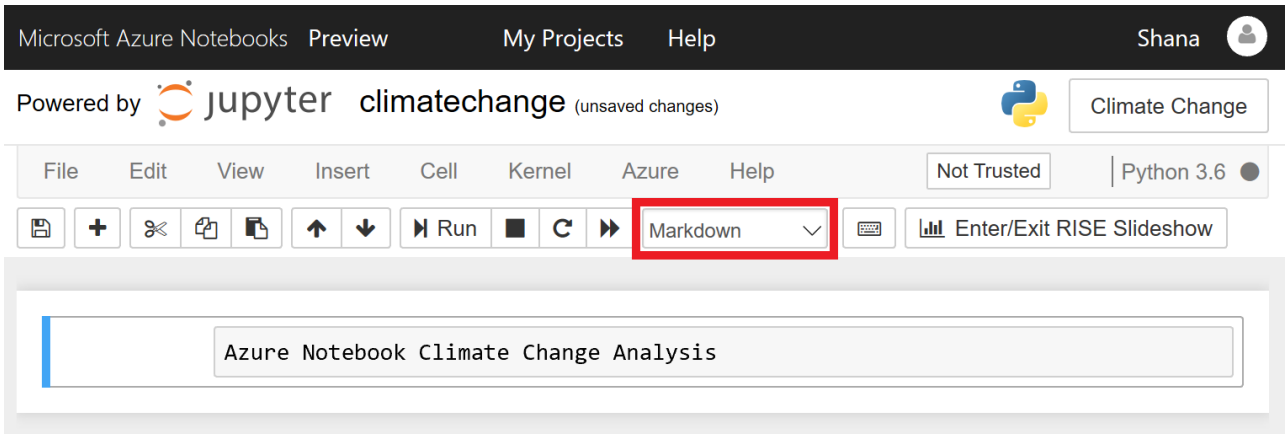
In this exercise, you will:

- Create a notebook in Azure Notebooks
- Upload, manipulate, and visualize data in a notebook
- Share notebooks onlineJupyter notebooks are composed of *cells*. Each cell is assigned one of three types:
- **Markdown** for entering text in markdown format
- **Code** for entering code that runs interactively
- **Raw NBConvert** for entering data inline

Code entered into code cells is executed by a *kernel*, which provides an isolated environment for the notebook to run in. The popular IPython kernel supports code written in Python, but dozens of other kernels are available supporting other languages. Azure Notebooks support Python, R, and F# out of the box. They also support the installation of the many packages and libraries that are commonly used in research.

The notebook editor currently shows an empty cell. In this exercise, you will add content to that cell and add other cells to import Python packages such as NumPy, load a pair of NASA data files containing climate data, and create a scatter plot from the data.

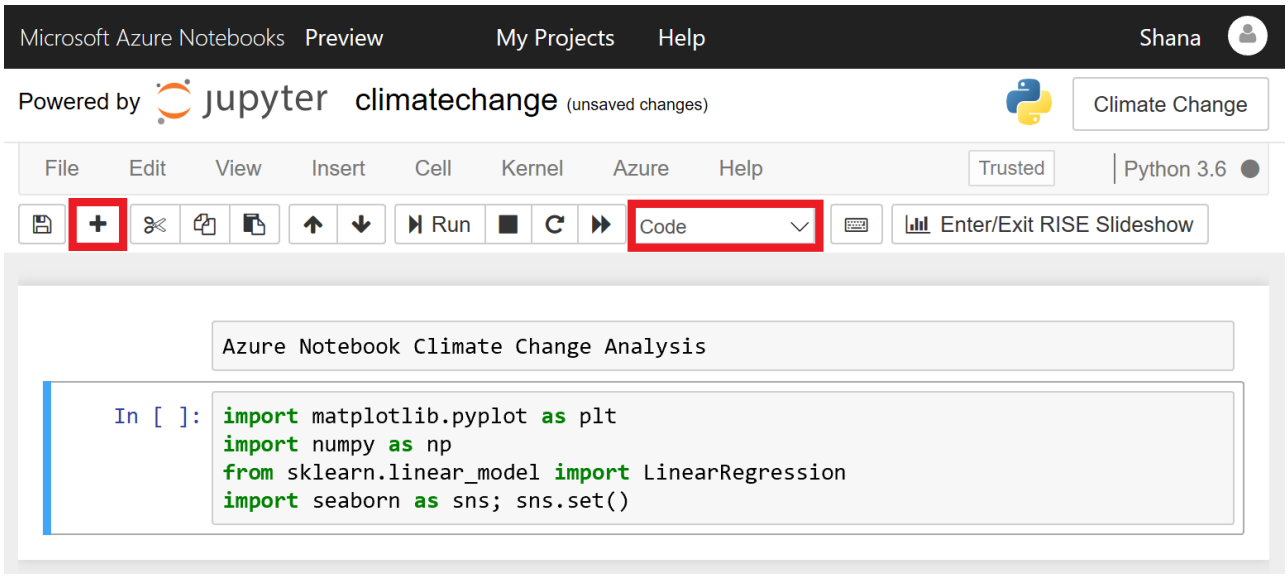
1. In the first cell, set the cell type to **Markdown** and enter the "Azure Notebook Climate Change Analysis" into the cell itself:



Defining a markdown cell

2. Click the **+** button in the toolbar to add a new cell. Make sure the cell type is **Code**, and then enter the following Python code into the cell:

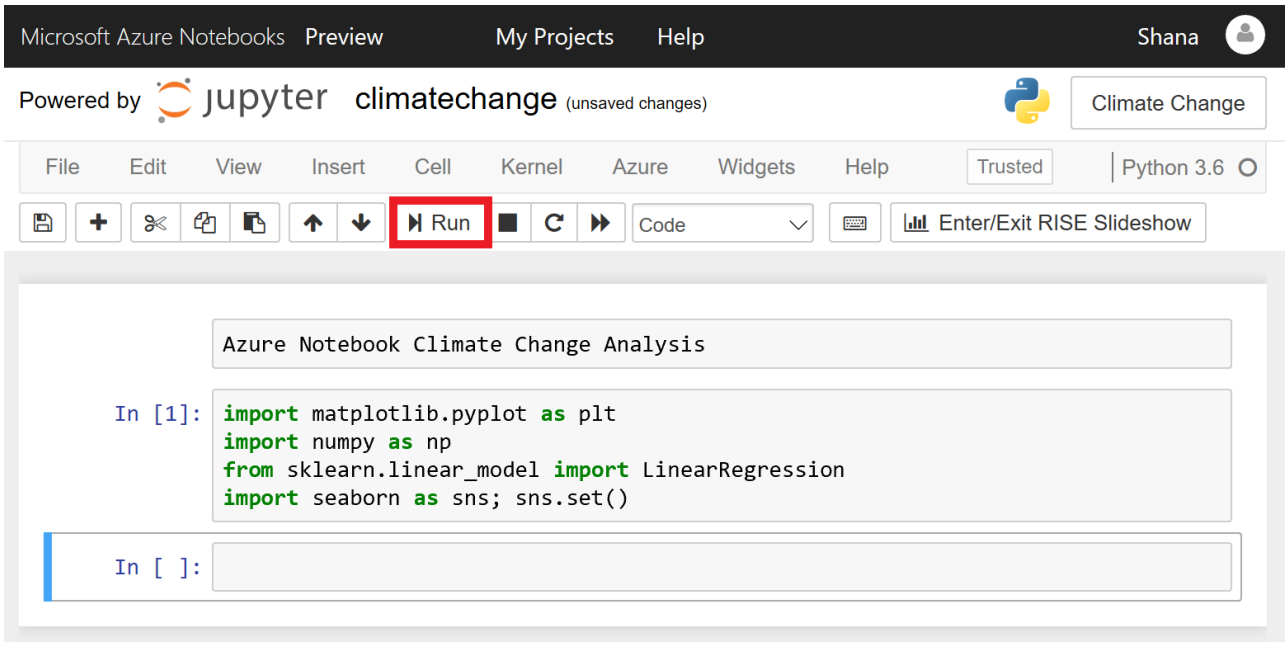
```
import matplotlib.pyplot as plt
import numpy as np
from sklearn.linear_model import LinearRegression
import seaborn as sns; sns.set()
```



Adding a code cell

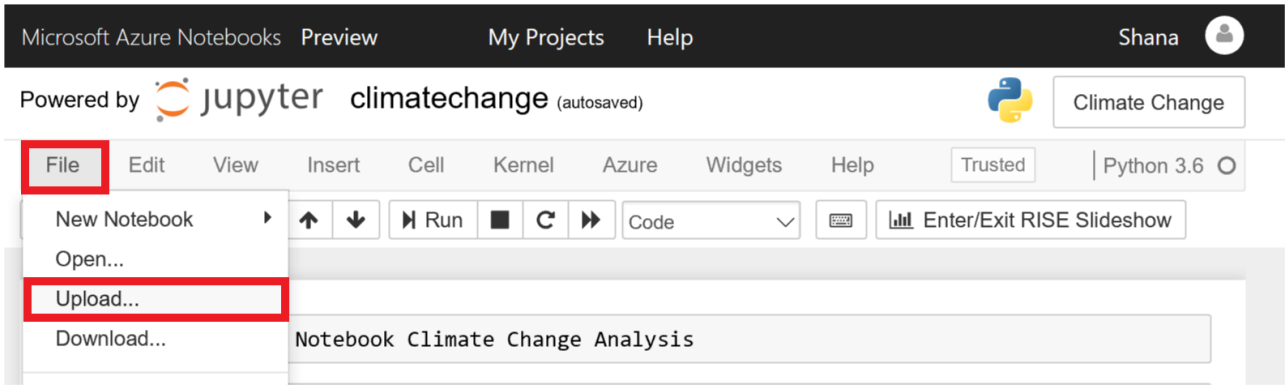
3. Now click the **Run** button to run the code cell and import the packages specified in the `import` statements. Ignore any warnings that are displayed as the environment is prepared for the first time.

> You can remove the warnings by selecting the code cell and running it again.



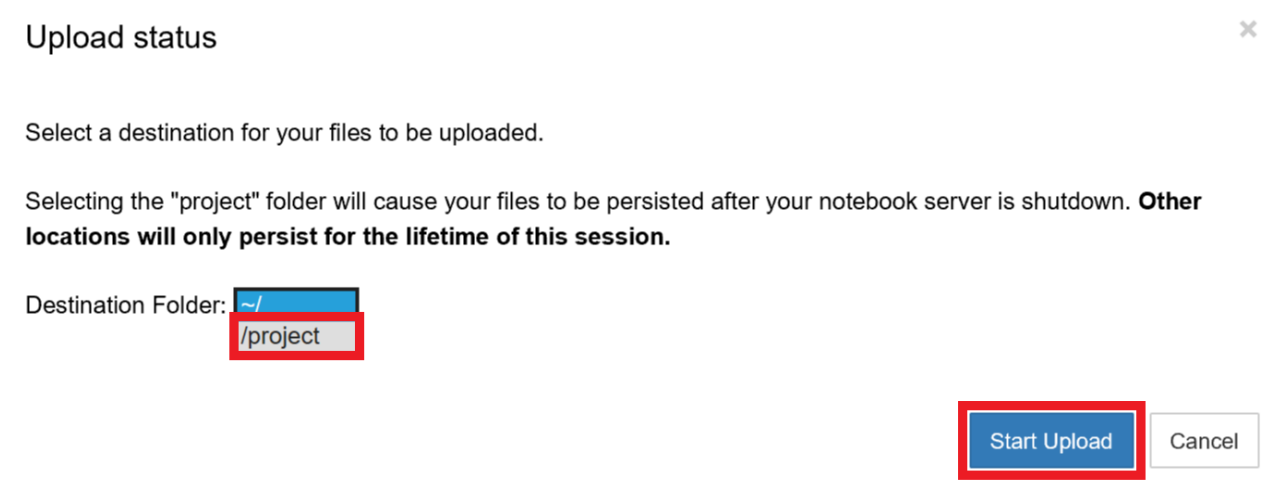
Running a code cell

4. Click **File** in the menu at the top of the page, and select **Upload** from the drop-down menu. Then upload the files named **5-year-mean-1951-1980.csv** and **5-year-mean-1882-2014.csv** from this link.



Uploading data to the notebook

5. Select **/project** as your **Destination Folder** to ensure your files persist. Click **Start Upload** to upload the files, and **OK** once they successfully upload.



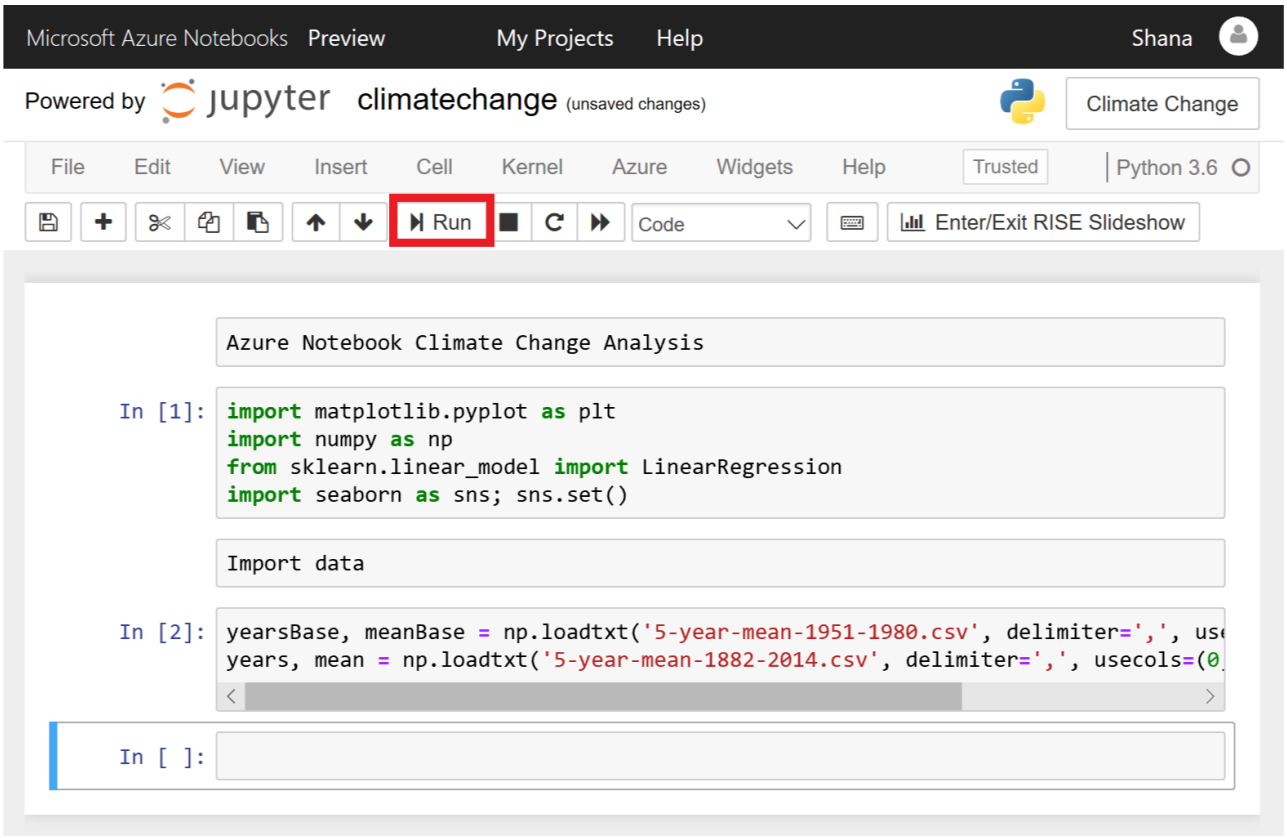
Selecting destination folder for data

6. Place the cursor in the empty cell at the bottom of the notebook. Enter "Import data" as the text and change the cell type to **Markdown**.

7. Now add a **Code** cell and paste in the following code.

```
yearsBase, meanBase = np.loadtxt('5-year-mean-1951-1980.csv', delimiter=',',
usecols=(0, 1), unpack=True)
years, mean = np.loadtxt('5-year-mean-1882-2014.csv', delimiter=',',
usecols=(0, 1), unpack=True)
```

8. Click the **Run** button to run the cell and use NumPy's `loadtxt` function to load the data that you uploaded. The data is now in memory and can be used by the application.



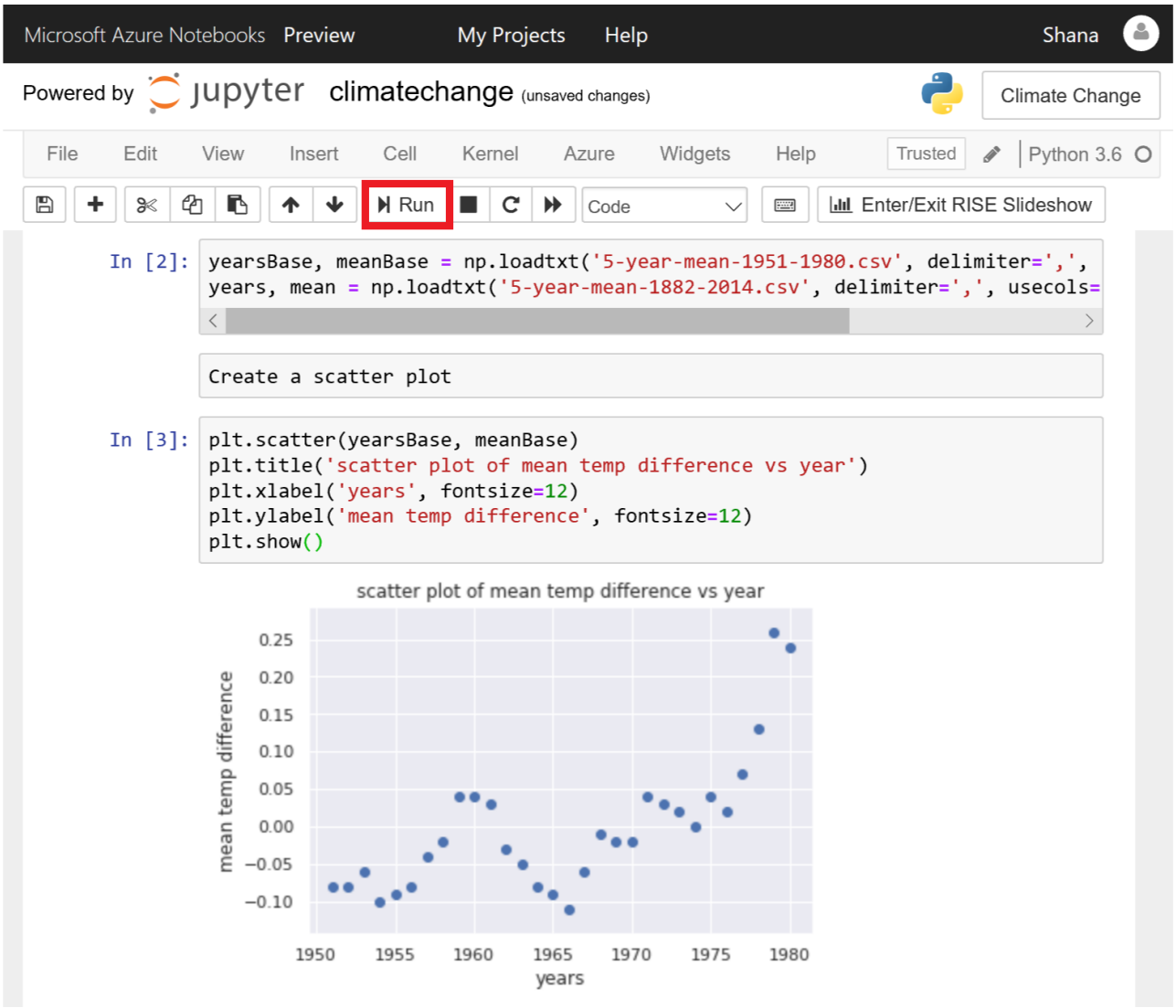
Loading the data

9. Place the cursor in the empty cell at the bottom of the notebook. Change the cell type to **Markdown** and enter "Create a scatter plot" as the text.

10. Add a **Code** cell and paste in the following code, which uses Matplotlib to create a scatter plot.

```
plt.scatter(yearsBase, meanBase)
plt.title('scatter plot of mean temp difference vs year')
plt.xlabel('years', fontsize=12)
plt.ylabel('mean temp difference', fontsize=12)
plt.show()
```

11. Click **Run** to run the cell and create a scatter plot.



Scatter plot produced by Matplotlib

The data set you loaded uses a 30-year mean between 1951 and 1980 to calculate a base temperature for that period, and then uses 5-year mean temperatures to calculate the difference between the 5-year mean and the 30-year mean for each year. The scatter plot shows the annual temperature differences. Scatter plots offer a handy means for visualizing data, but suppose you wanted to overlay the scatter plot with a trend line showing how the data is trending over time. One way to compute such trend lines is linear regression. In this exercise, you will use NumPy to perform a linear regression and Matplotlib to draw a trend line from the data.

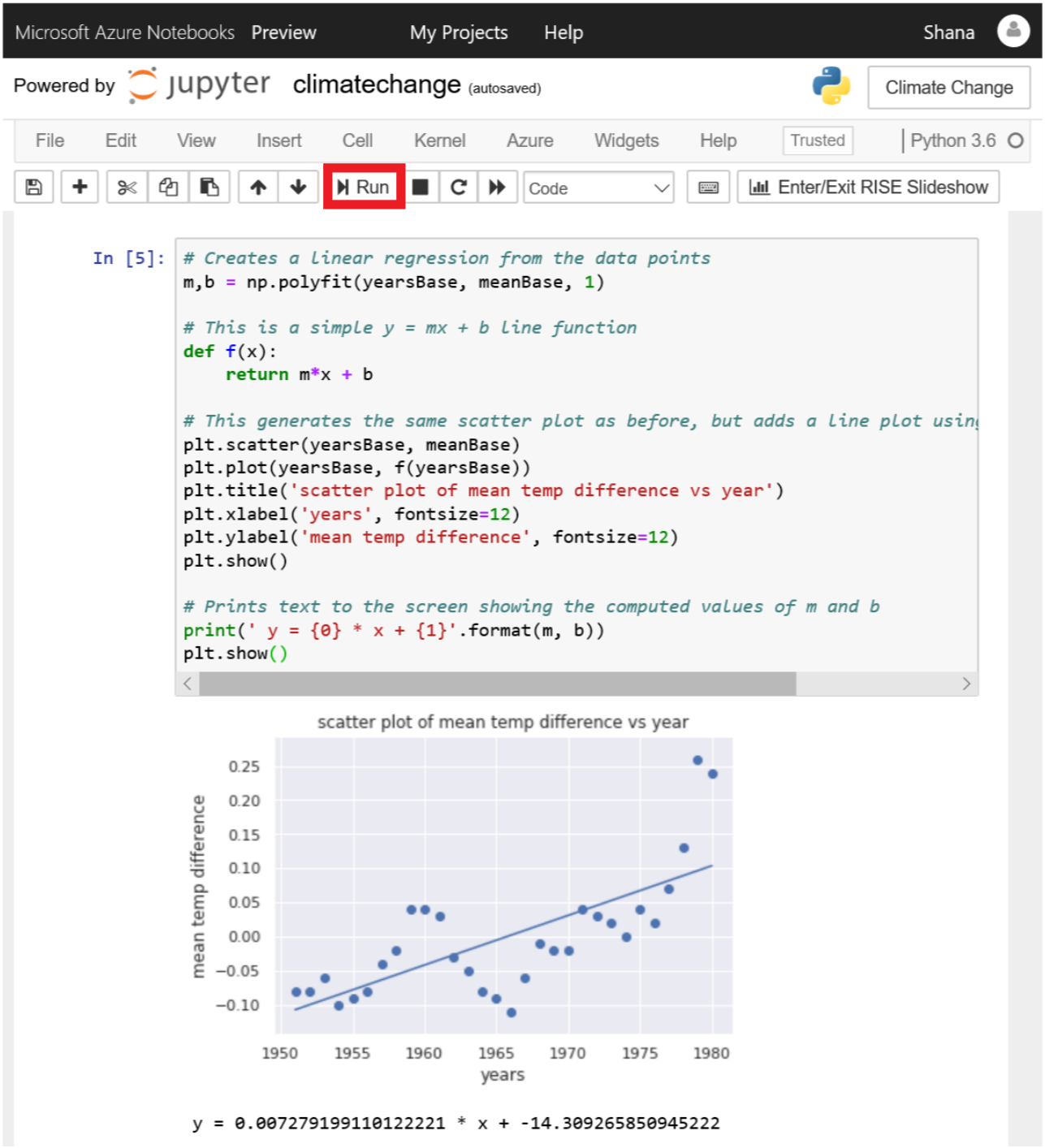
1. Place the cursor in the empty cell at the bottom of the notebook. Change the cell type to **Markdown** and enter "Perform linear regression" as the text.

2. Add a **Code** cell and paste in the following code. Take a moment to read the comments (the lines that begin with # signs) to understand what the code is doing.

```
# Creates a linear regression from the data points
m,b = np.polyfit(yearsBase, meanBase, 1)

# This is a simple y = mx + b line function
def f(x):
```

```
    return m*x + b

# This generates the same scatter plot as before, but adds a line plot using
the function above
plt.scatter(yearsBase, meanBase)
plt.plot(yearsBase, f(yearsBase))
plt.title('scatter plot of mean temp difference vs year')
plt.xlabel('years', fontsize=12)
plt.ylabel('mean temp difference', fontsize=12)
plt.show()

# Prints text to the screen showing the computed values of m and b
print(' y = {0} * x + {1}'.format(m, b))
plt.show()
```

3. Now run the cell to display a scatter plot with a regression line.



Scatter plot with regression line

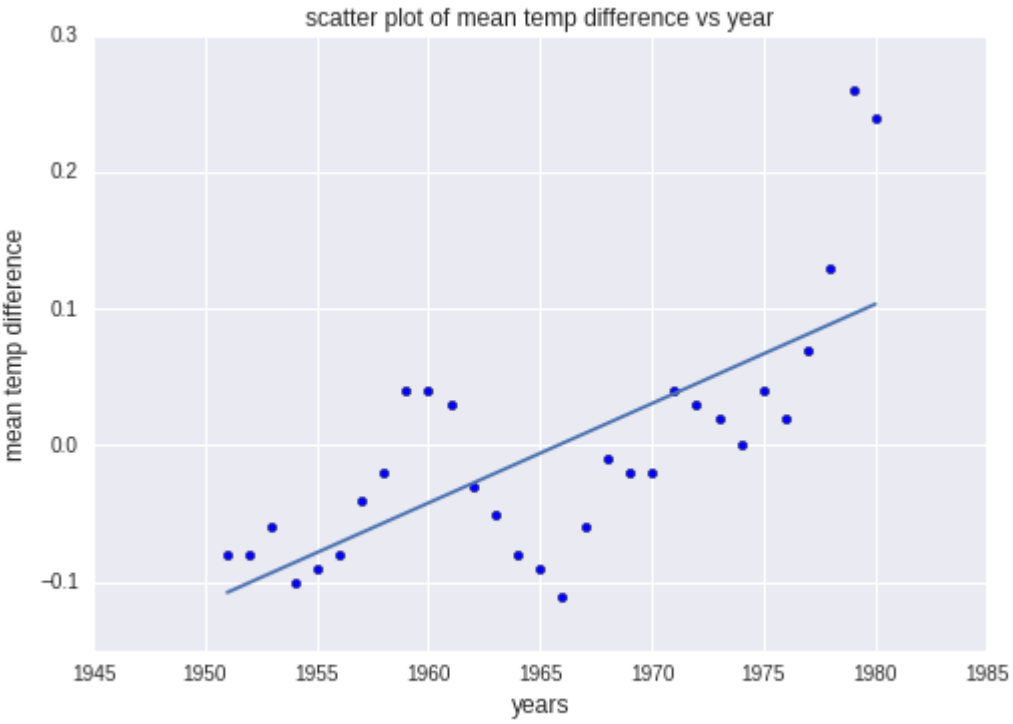
From the regression line, you can see that the difference between 30-year mean temperatures and 5-year mean temperatures is increasing over time. Most of the computational work required to generate the regression line was done by NumPy's `polyfit` function, which computed the values of `m` and `b` in the equation y = mx + b.Another popular Python library that is widely used in the research community is scikit-learn, which excels at building machine-learning models to help extract information from data. In this exercise, you will use scikit-learn (which was already imported in Unit 2) to compute a trend line for the NASA climate data.

1. Place the cursor in the empty cell at the bottom of the notebook. Change the cell type to **Markdown** and enter "Perform linear regression with scikit-learn" as the text.

2. Add a **Code** cell and paste in the following code.

```
# Pick the Linear Regression model and instantiate it
model = LinearRegression(fit_intercept=True)

# Fit/build the model
model.fit(yearsBase[:, np.newaxis], meanBase)
mean_predicted = model.predict(yearsBase[:, np.newaxis])

# Generate a plot like the one in the previous exercise
plt.scatter(yearsBase, meanBase)
plt.plot(yearsBase, mean_predicted)
plt.title('scatter plot of mean temp difference vs year')
plt.xlabel('years', fontsize=12)
plt.ylabel('mean temp difference', fontsize=12)
plt.show()

print(' y = {0} * x + {1}'.format(model.coef_[0], model.intercept_))
```

3. Now run the cell to display a scatter plot with a regression line.




```
y = 0.007279199110122357 * x + -14.309265850945492
```

Scatter plot with regression line computed by sckikit-learn

The output is almost identical to the output in the previous exercise. The difference is that scikit-learn did more of the work for you. Specifically, you didn't have to code a line function as you did with NumPy; scikit-learn's `LinearRegression` function did it for you. scikit-learn supports *many* different types of regression, which comes in handy when building sophisticated machine-learning models.One of the cool things about Azure Notebooks — and Python in general — is there are thousands of open-source libraries you can leverage to perform complex tasks without writing a lot of code. In this unit, you'll use Seaborn, a library for statistical visualization, to plot the second of the two data sets you loaded, which covers the years 1882 to

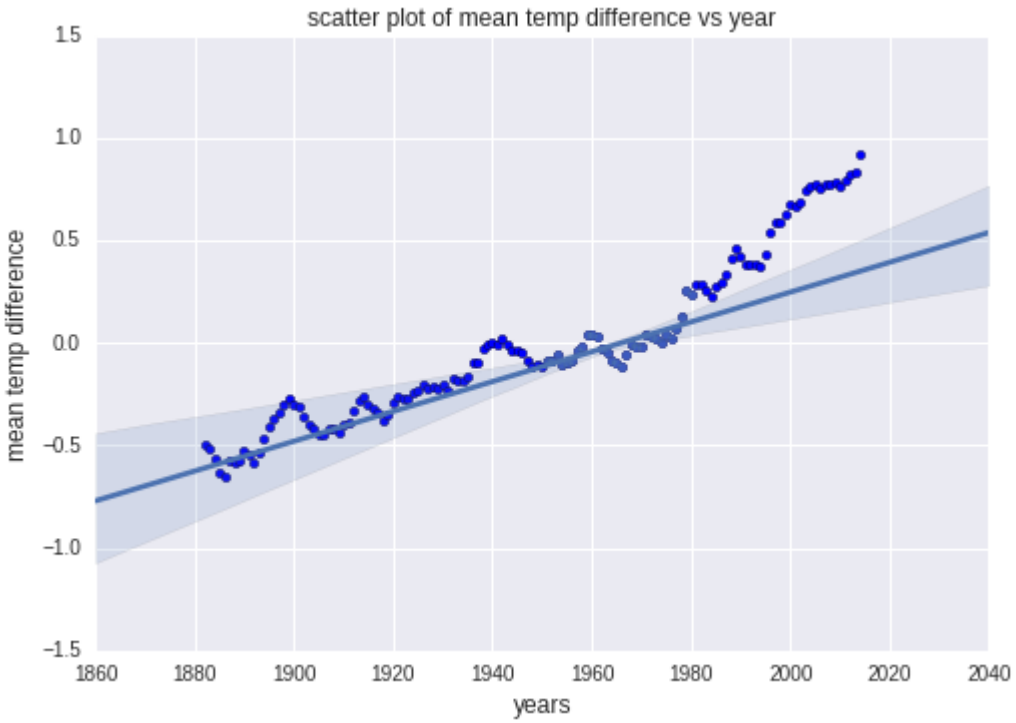
2014. Seaborn can create a regression line accompanied by a projection showing where data points should fall based on the regression with one simple function call.

1. Place the cursor in the empty cell at the bottom of the notebook. Change the cell type to **Markdown** and enter "Perform linear regression with Seaborn" as the text.

2. Add a **Code** cell and paste in the following code.

```
plt.scatter(years, mean)
plt.title('scatter plot of mean temp difference vs year')
plt.xlabel('years', fontsize=12)
plt.ylabel('mean temp difference', fontsize=12)
sns.regplot(yearsBase, meanBase)
plt.show()
```

3. Run the code cell to produce a scatter chart with a regression line *and* a visual representation of the range in which the data points are expected to fall.

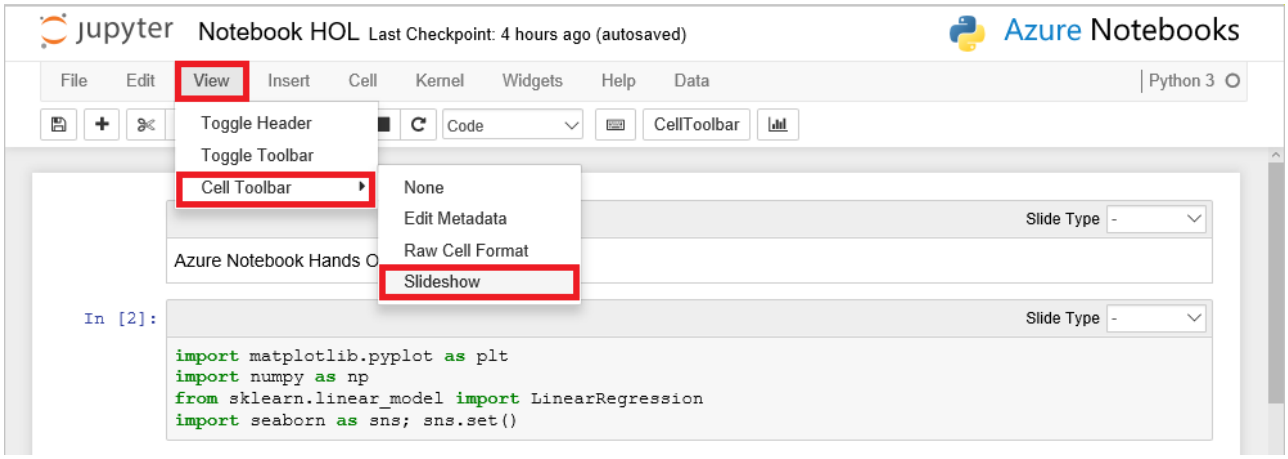


Comparison of actual values and predicted values generated with Seaborn

Notice how the data points for the first 100 years conform nicely to the predicted values, but the data points from roughly 1980 forward don't. It's models such as these that lead scientists to believe that climate change is accelerating.

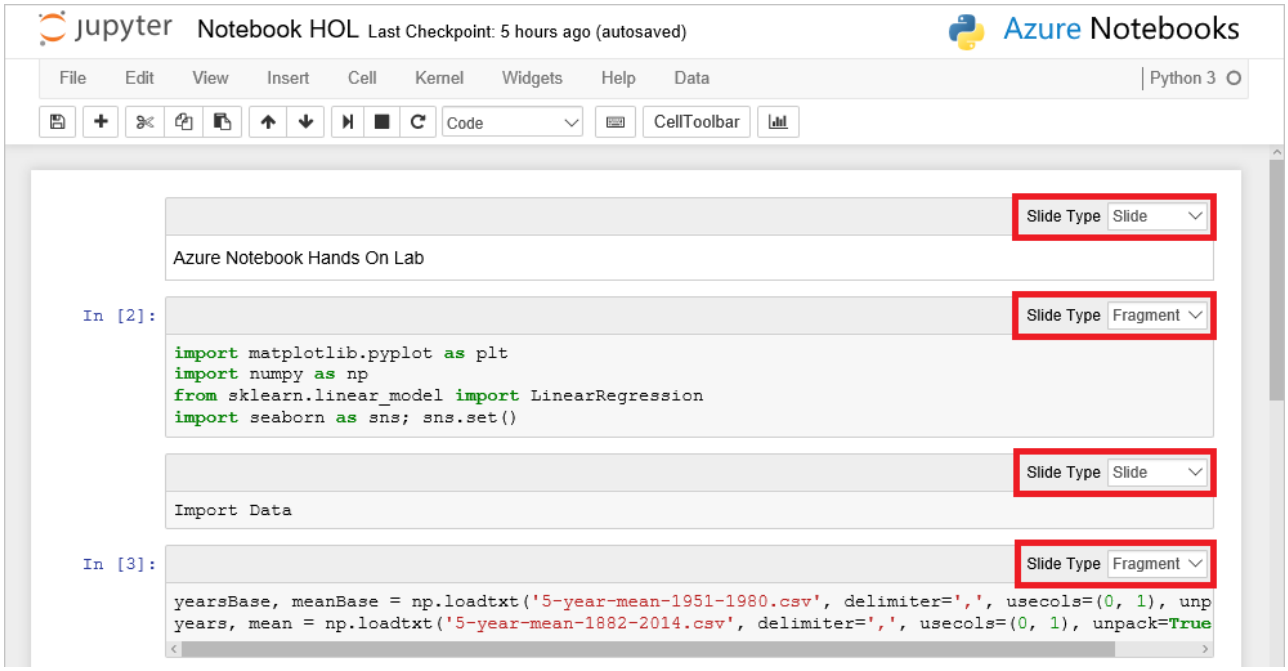
What if you wanted to take a notebook you've created and use it in a presentation? You can use create slide shows from the cells in a notebook and play them back when it's presentation time. In this exercise, you will create a slide show from the notebook you built in the previous exercises.

1. Scroll up to the top of the notebook. Then select **View** -> **Cell Toolbar** -> **Slideshow**. This will display a **Slide Type** drop-down in each cell for specifying how individual cells behave during a slide show.



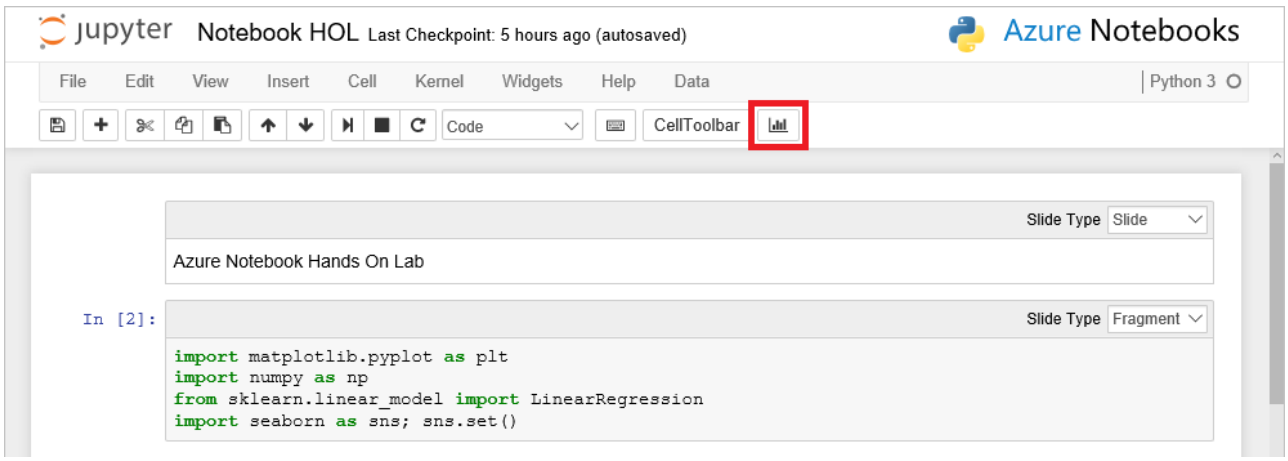
Toggling the Slide Type display

2. Set the **Slide Type** for each markdown slide in the notebook to **Slide**. Set the **Slide Type** for each code cell to **Fragment**.



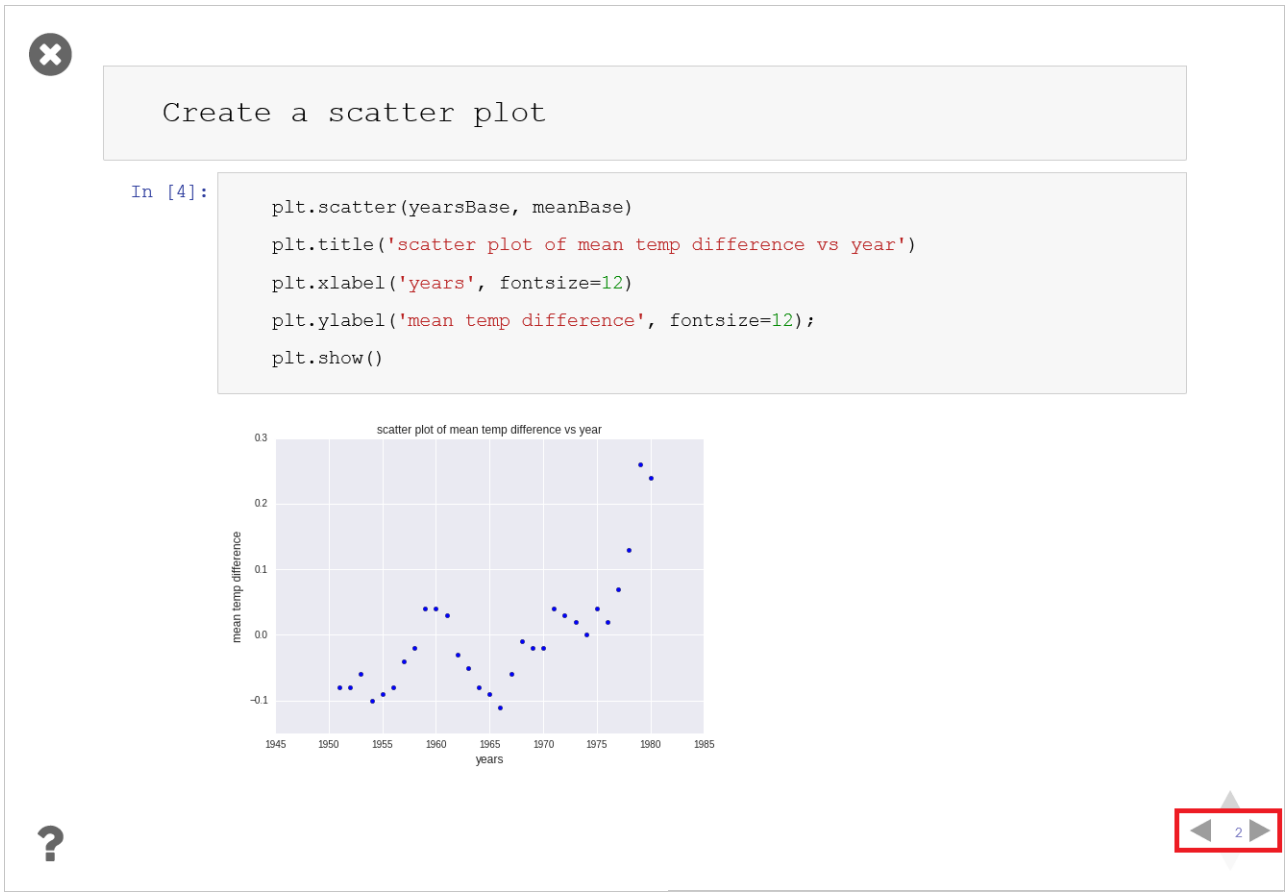
Specifying the slide type for individual cells

3. Click the **Slideshow** button to play the slide show.



Starting the slide show

4. Maximize the browser window (or switch the browser to full-screen mode if your browser supports it). Then use the arrow buttons in the lower-right corner of the page (or the left and right arrows keys on the keyboard) to navigate backward and forward in the slide show.

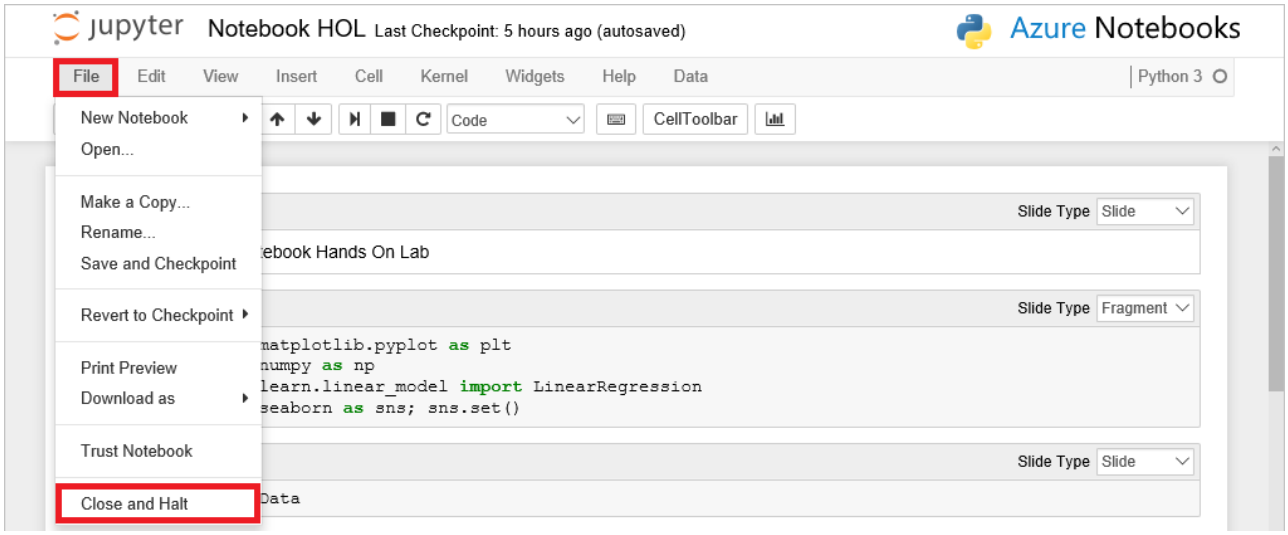


Viewing the slide show

5. When you're finished, click the **X** in the upper-left corner of the page to end the slide show.

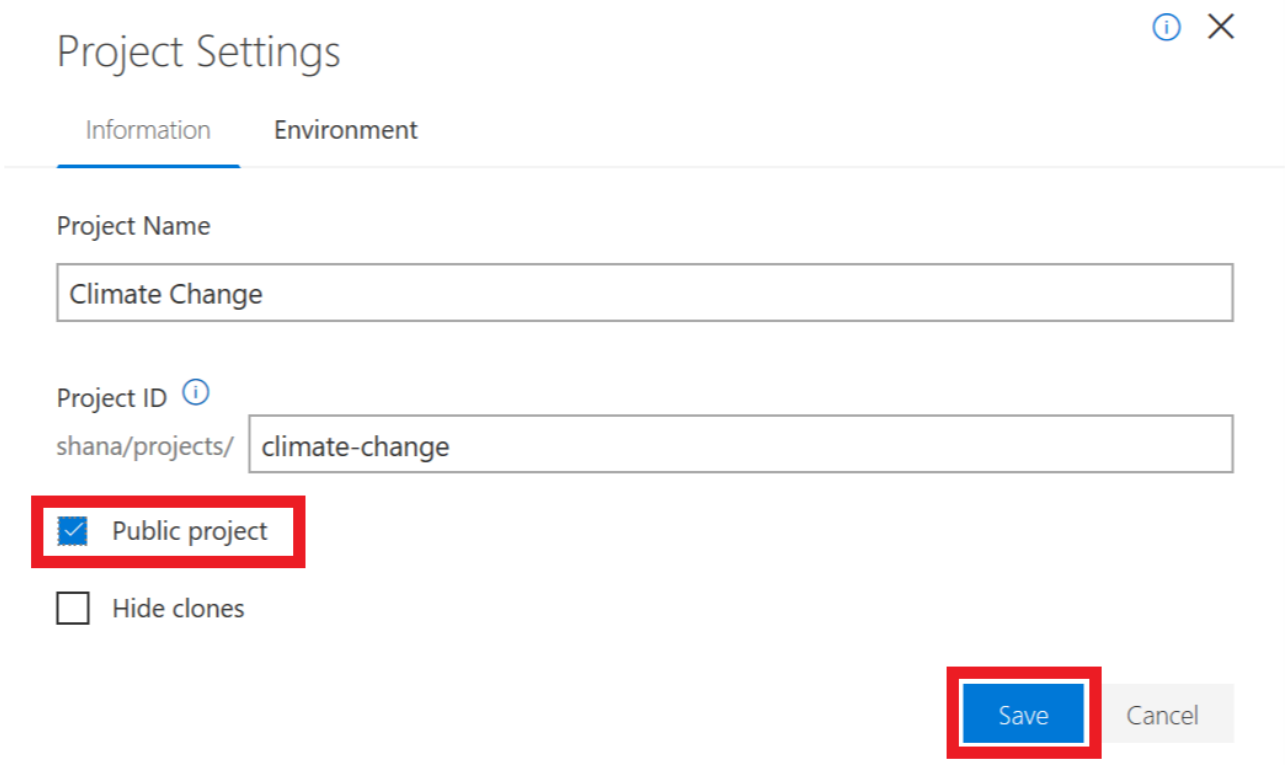
Creating slide shows is easy. But what if you want to share a notebook with colleagues so they can use it, too? That is the subject of the next exercise.One of the value-added features of Azure Notebooks is that it provides a cloud-based hub for sharing notebooks. In this unit, you'll share the notebook you created in previous exercises.

1. Select **File** -> **Close and Halt** to close the notebook.



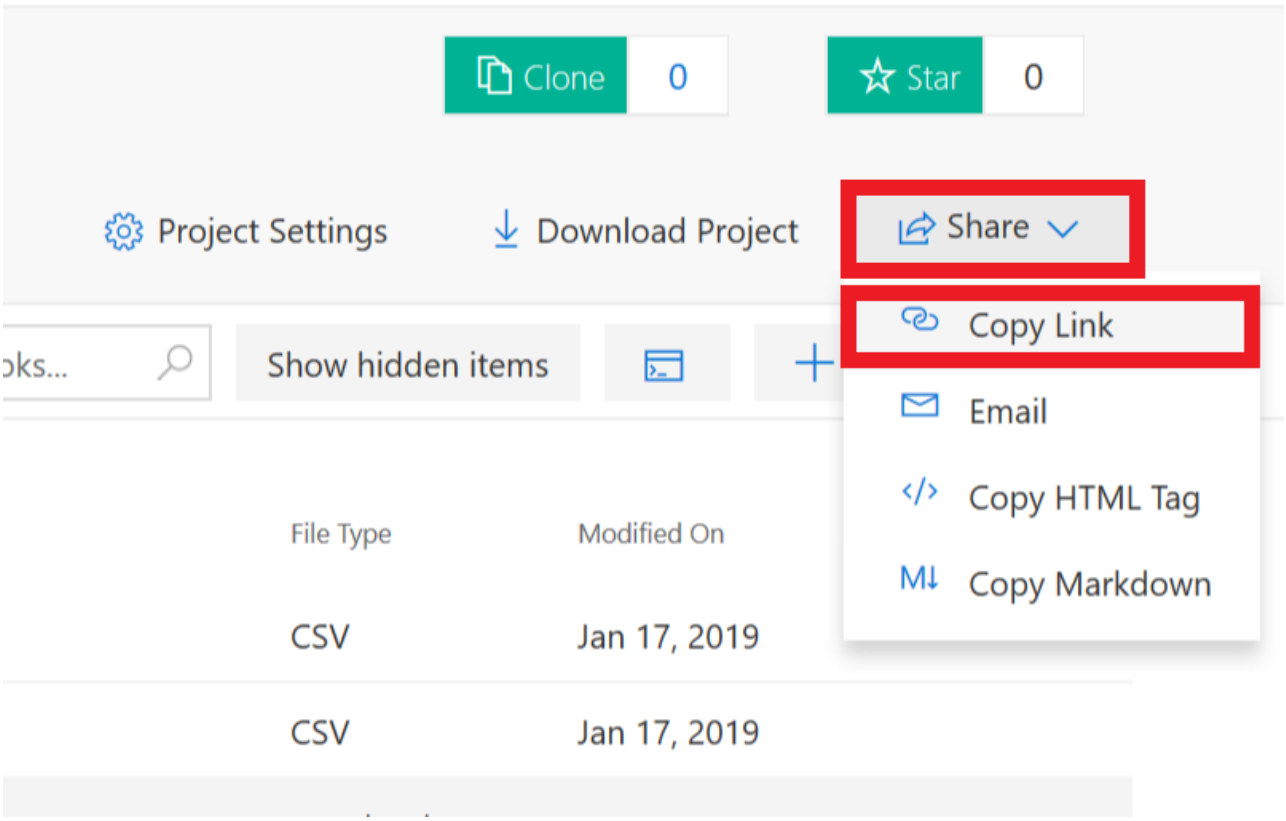
Closing the notebook

2. Click **Project Settings** to edit the project's settings. Check the **Public project** box to make the project public, and then click **Save**.



Making the project public

3. Click **Share**. Notebooks can be shared by links, on social media, and through email. To demonstrate, click **Copy Link** to copy a link to the notebook to the clipboard. Then paste the link into a separate browser window and confirm that the notebook appears there.



Sharing by link

Another way to share a notebook is to download it as a **.ipynb** file and send the **.ipynb** file to whomever you wish to share it with. You can download a notebook and make a local copy by clicking the **Download Project** button. You can even run them in other Jupyter environments if you would like because there's nothing proprietary about Azure Notebooks.There's much more to do and learn with Azure Notebooks, like integrate with Azure Machine Learning, and connect the notebook to your own Azure compute source. The Azure Notebooks Web site contains several sample notebooks that you can experiment with and learn from. Here are two great examples.

- Discover Sentiments in Tweets performs sentiment analysis on 160,000 tweets, and uses the word_cloud package to generate word clouds from the tweets.
- Introduction to Cognitive Toolkit is a library of notebooks that demonstrate how to use the Microsoft Cognitive Toolkit to build sophisticated machine-learning models.

Check out the Azure Notebooks home page for additional sample notebooks, and use them to deepen your understanding of Jupyter and sharpen your data-science skills.

Learn more

- Azure Notebooks Web site
- Azure Notebooks documentation
- Azure Notebooks samples