4
Data Manipulation

So far we have learned about the basics of RPA and how to organize steps in a workflow using a Flowchart or Sequence. We now know about UiPath components and have a thorough understanding of UiPath Studio. We used a few simple examples to make our first robot. Before we proceed further, we should learn about variable and data manipulation in UiPath. It is not very different from other programming concepts. However, here we will look at the specifics of UiPath data handling and manipulation.

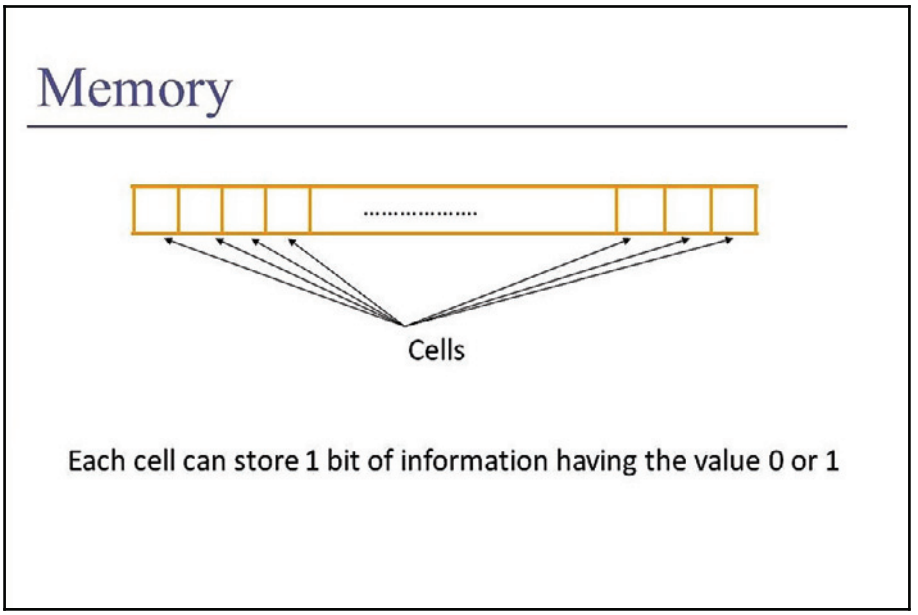
This chapter will mainly deal with data manipulation. Data manipulation is the process of changing data—whether it is adding, removing, or updating it. Before learning about data manipulation, we shall see what variables, collections, and arguments are, what kind of data they store, and what their scope is. We will then carry out various examples of data manipulation. We will also learn to store and retrieve data.

In this chapter, we will cover:

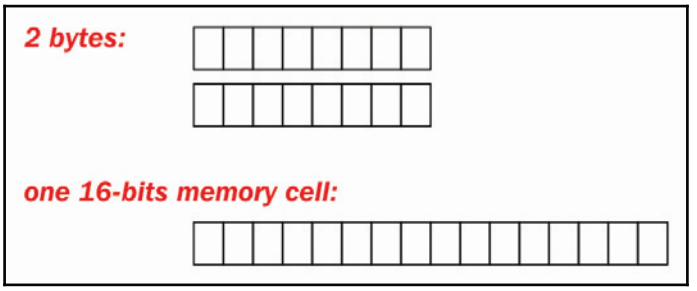
- Variables and the scope of a variable in the workflow
- Collections, how to store data in arrays, and how to traverse them
- Arguments, why we need them, and how to use them
- Clipboard usage
- Data scraping
- File management with a step-by-step example
- Data table usage with an example

Variables and scope

Before discussing variables, let us take a look at **Memory** and its structure:



Memory consists of millions of memory **Cells** and each memory cell stores data in the form of 0s and 1s (binary digits). Each cell has a unique address, and by using this address, the cell can be accessed:



When data is stored in memory, its content gets split into further smaller forms (binary digits). As shown in the preceding diagram, **2 bytes** of data consists of several memory cells.

A variable is the name that is given to a particular chunk of memory cells or simply a block of memory and is used to hold data.

You can declare any desired name and create a variable to store the data.

It is recommended, however, that we use meaningful variable names. For example, if we wish to create a variable to store the name of a person, then we should declare

Name: Andy

It is a good practice to create meaningful variable names. This becomes very useful in debugging the program.

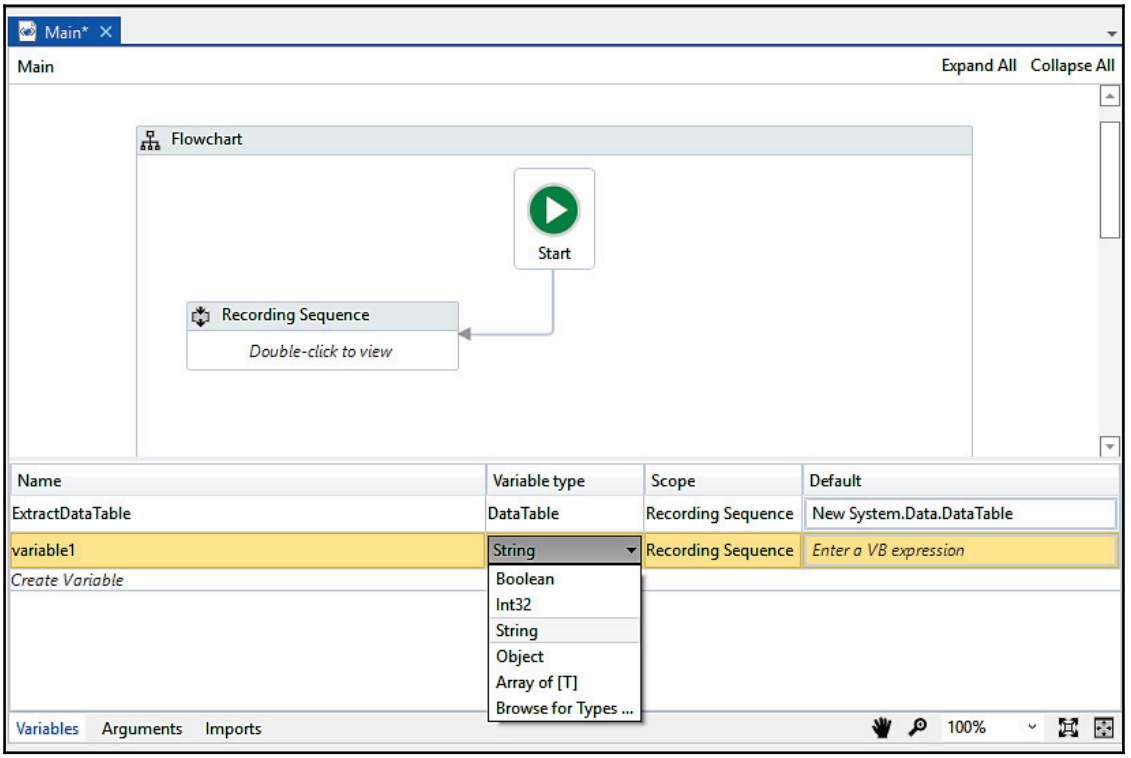
As we discussed, a variable is used to store data. Data is present around us in different types—it can be an mp3 file, text file, string, numbers, and so on. That is why variables are associated with their respective data types. A particular type of variable can hold only that type of data. If there is a mismatch between the data and the variable type, then an error occurs. The following table shows the type a of variable available with UiPath:

Type	**Content**
Integer	Whole numbers
String	Text of any kind: "The Quick Fox @4598"
Boolean	True or false
Generic	Anything

In UiPath, we can declare a variable in the **Variables** section. Just give it a meaningful name and select the appropriate type from the drop-down list.

By a meaningful variable, it is implied that the variable name should not be ambiguous. Try to make it as descriptive as possible so that the person reading the code understands the purpose of the variable. Good examples are `daysDateRange`, `flightNumber`, and `carColour`. Bad examples are `days`, `dRange`, `temp`, and `data`.

We can also specify the scope of a variable. The **Scope** is the region under which the data has its effect or availability. You can choose the **Scope** of the variable according to your requirements; try to limit it as far as possible. Please refer to the following screenshot to understand **Variables** panel:

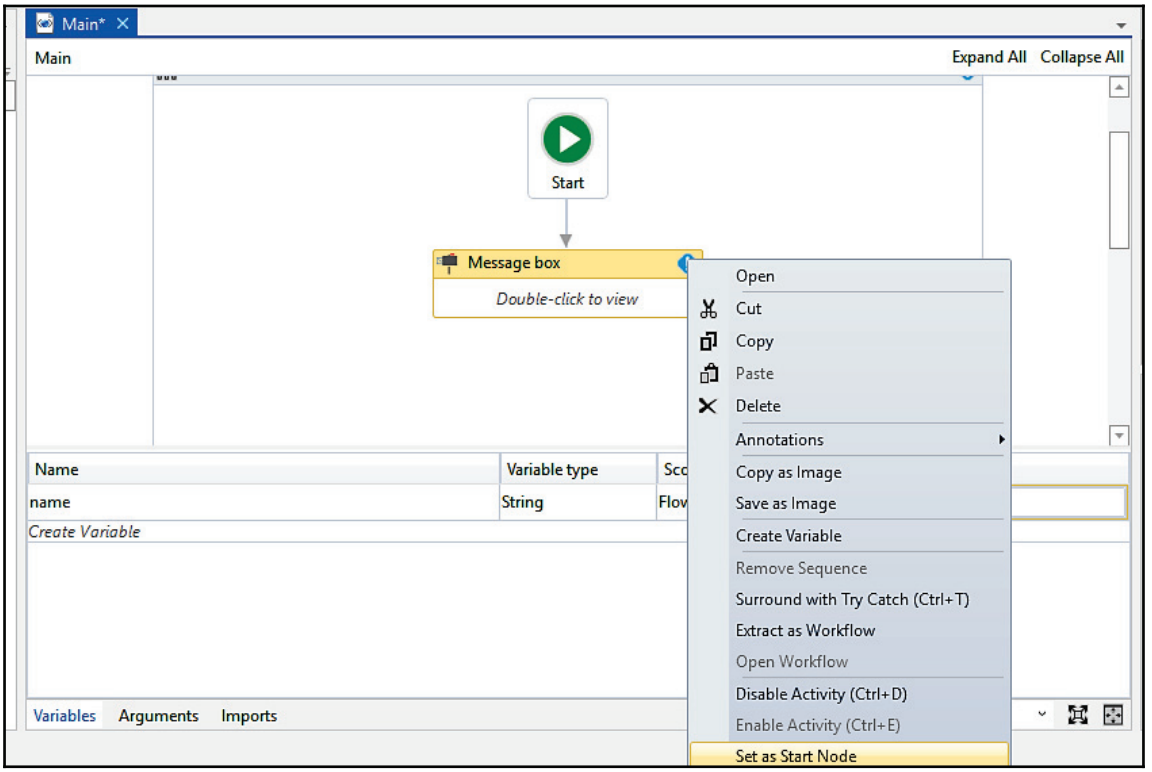


Creating a variable

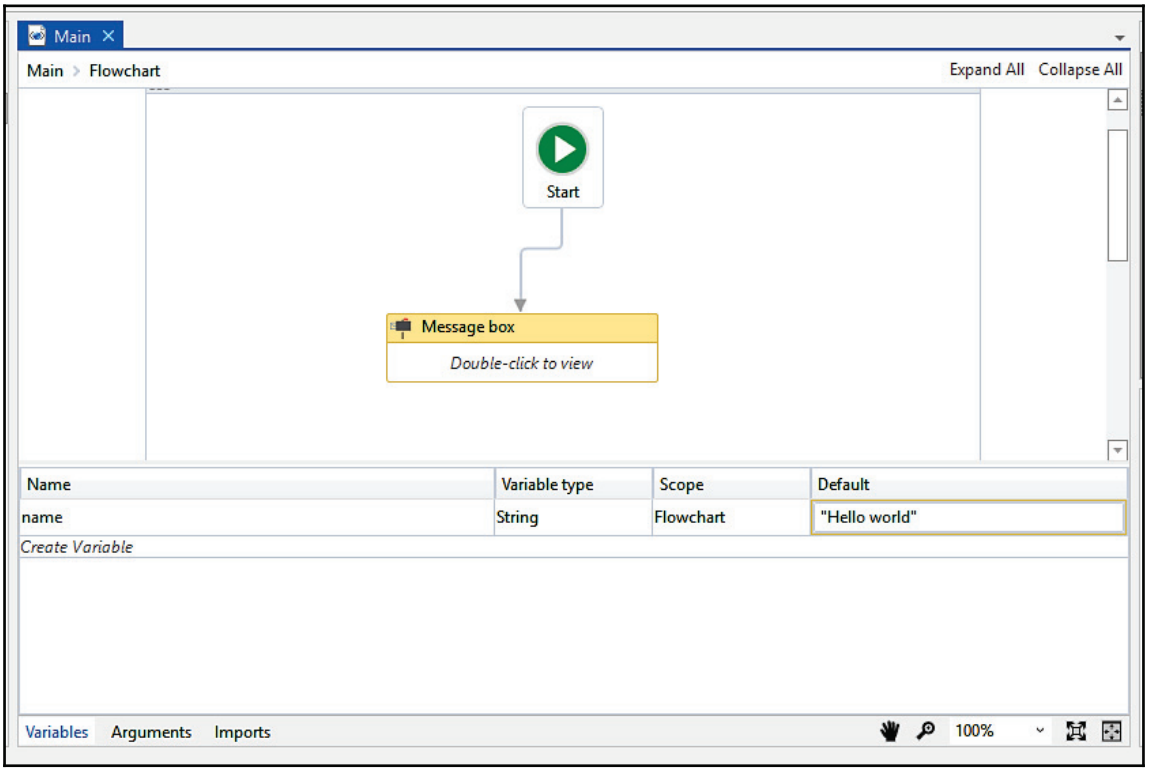
For security reasons, it is not a good practice to set the **Scope** of your variable to fullest as it may accidentally be accessed by another region or could be modified.

Let us take an example of creating a variable and then displaying a **Message box** using that variable:

1. We have declared a variable as `name` in the **Variables** section and set its **Default** value to `"Hello world"`. By default, the type of the variable is **String** (we can change its type according to our needs).
2. Search for `Message box` in the **Activities** panel. Drag and drop that **Message box** template into a **Flowchart**.
3. Right-click on the message template and select **Set as Start node**:



4. Double-click on the **Message box** template and specify the variable name that we created earlier. At this stage, we are ready to run our application by simply clicking on the **Run** button:



A dialogue box will pop up with the `"Hello world"` text displayed on it.

Collections

There are different types of variables. Variables can be classified into three categories:

- **Scalar**: These are variables that can only hold a single data point of a particular data type, for example; Character, Integer, Double, and so on.
- **Collections**: These are variables that can hold one or more data point of a particular data type. For example; array, list, dictionary, and so on.
- **Tables**: These are a tabular form of the data structure which consists of rows and columns.

In this section, we are going to see how collections work and how we can store values in the collection variables.

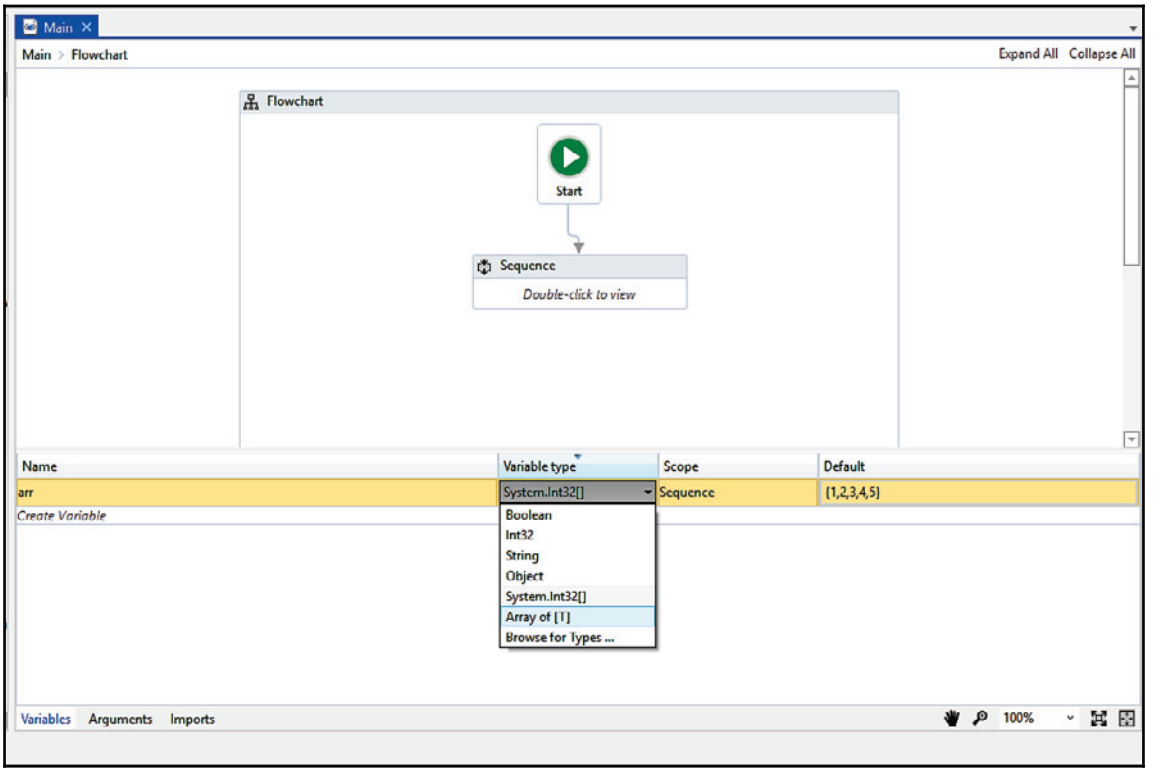
In a collection, we can store one or more data points, but all the data must be the same. Consider an example. An array is a collection in which we can store different values of a particular data type. It is a fixed data type, meaning if we store five values inside the array, we cannot add or remove any value/values in that array.

The object is a data type in which you can store any type of data. Hence, if we take an array of objects then we can store different types of data in an array. This is an exceptional case.

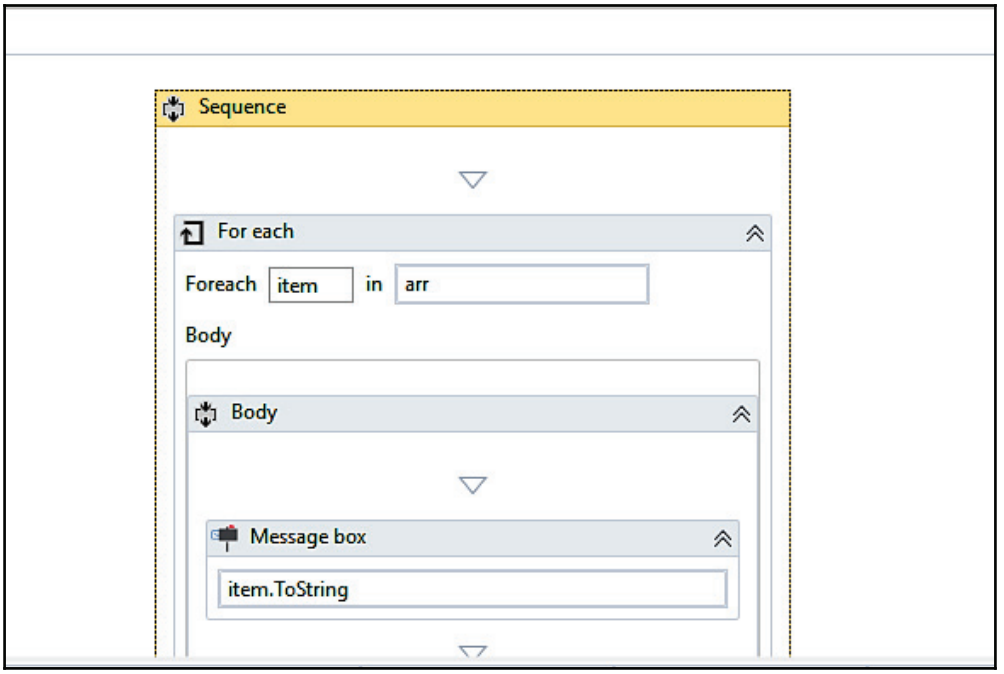
Let us see how we can use an array with an example. In this example, we are going to take an array of integers, initialize it, and then iterate through all the elements of the array:

1. Drag and drop a **Flowchart** activity onto the main Designer panel, and drag and drop a **Sequence** activity inside the **Flowchart**. Set the sequence as **Start** node.
2. Create a variable in the **Variables** panel and give it a meaningful name (in this example, we have created a variable named `arr`, which is an array of integers). Choose the data type as an array of integers.

3. We have initialized the array as `{1, 2, 3, 4, 5}` in the **Default** section. You can initialize it with the **int32** data type:



4. Drag and drop a **For each** activity from the **Activities** panel inside the **Sequence**, and drag and drop a **Message box** activity inside the **For each** activity.
5. Specify the array name in the expression text box of the **For each** activity.
6. Specify the `item` variable that is auto-generated by the **For each** activity, inside the **Message box** activity. But hold on, we have to convert the `item` variable into the **String** type because the **Message box** activity is expecting the string data type in the text box. Just press the dot (`.`) along with the `item` variable and choose the **ToString** method:



Hit the **Run** button to see the result. All the values will pop up at once.

In this example, we have seen how easily we can initialize the array and iterate through it.

Arguments – Purpose and use

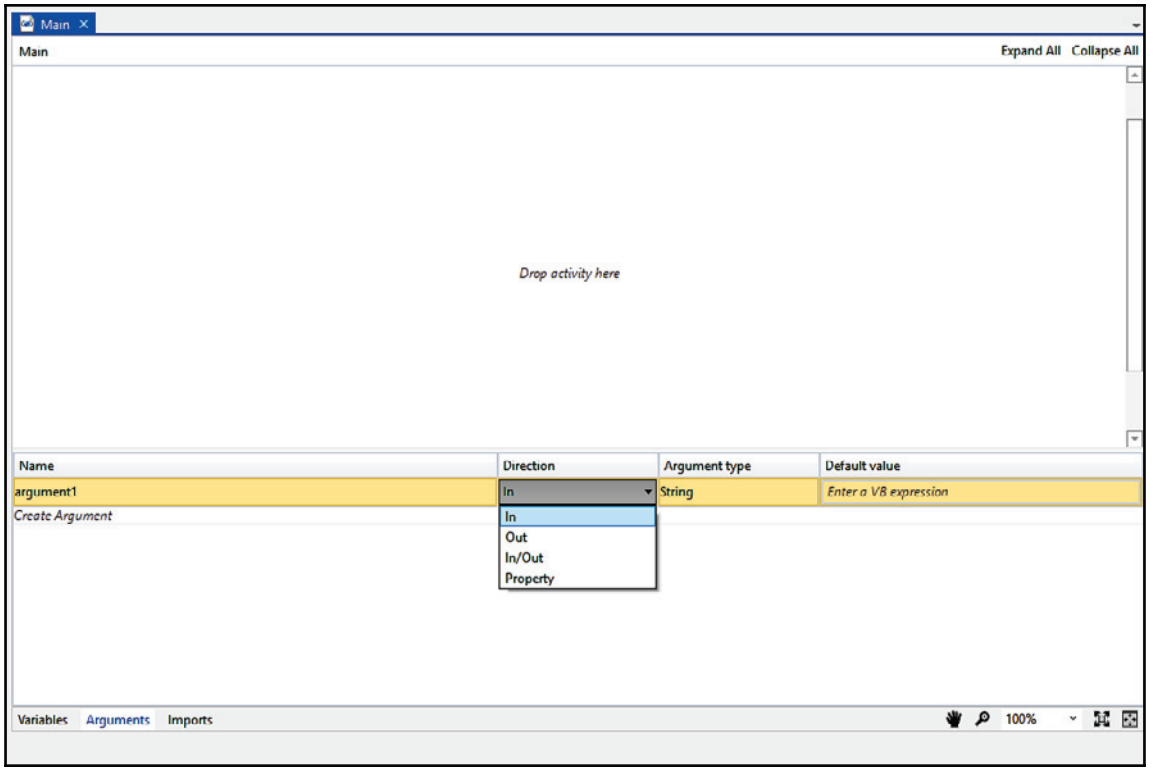
An **Argument** is simply a variable that can store a value. You can create an argument in the Argument section of the main Designer panel.

But remember, they are not limited to variables. An argument has a larger scope than a variable and is used to pass values between different workflows. You might be wondering why we need this. Suppose we have a big project to build; we break down the project into different workflows because smaller workflows can be easily tested separately. It is very easy to build smaller workflows and combine them, thus turning them into the real solution of the project.

These Arguments are used for interacting with different workflows by exchanging data between them. That is why the direction property is associated with Arguments. We can choose the direction on the basis of our requirement—either giving the value to some workflow or receiving the value from another workflow.

We can easily create arguments in the **Arguments** panel. We can also specify the direction:

- **In**: When we have to receive the value from another workflow.
- **Out**: This is the current value if we have to send the value to a workflow.
- **In/Out**: This specifies both; it can take or receive the value.
- **Property**: This specifies that it is not being used currently:



Data table usage with examples

A data table is a tabular form of data structure. It contains rows and each row has columns, for example:

Student name	Roll number	Class
Andrew Jose	1	3
Jorge Martinez	2	3
Stephen Cripps	3	2

The preceding illustration is an example of a data table that has three rows and three columns. You can build a data table in UiPath also.

A data table is used for various purposes. Say, for example, you have to build a table dynamically. You can use a data table as your preferred choice. A data table is also extensively used to store tabular data structures. In data scraping, data tables are widely used. Data scraping is a method in which we can dynamically create tabular data records of search items on the web.

We shall build two projects in which we will use a data table:

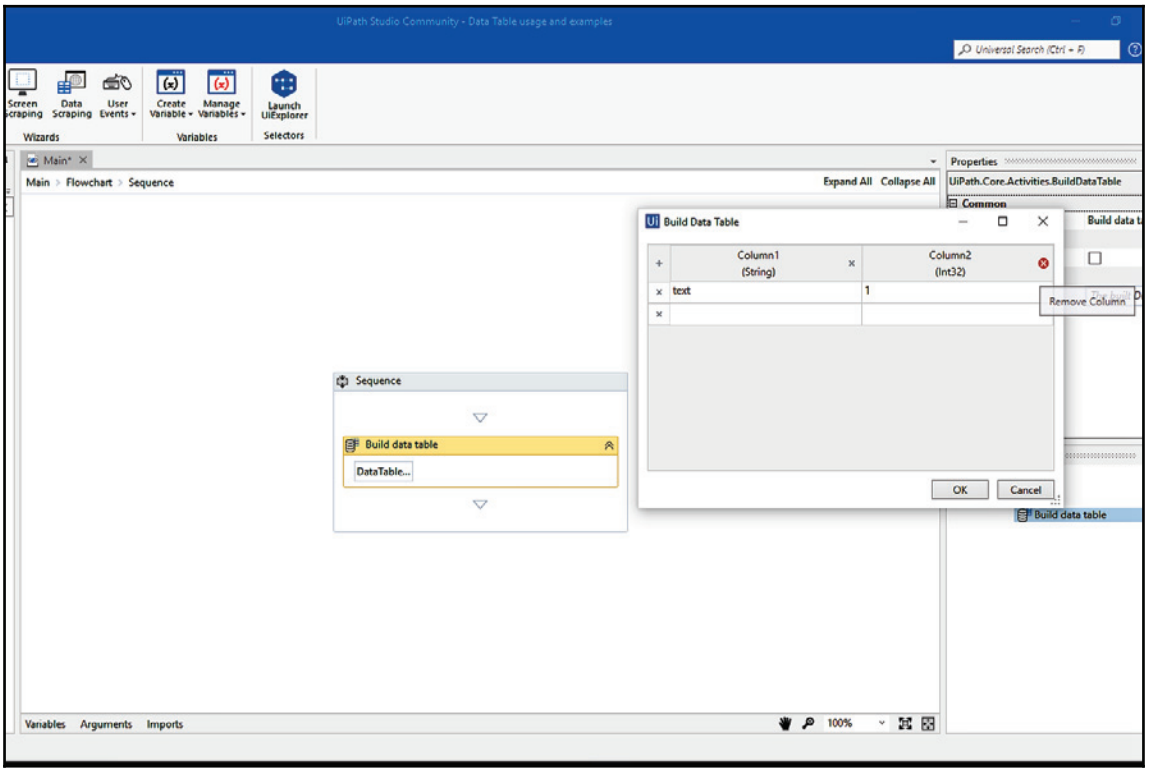
- Building a data table
- Building a data table using data scraping (dynamically)

Building a data table

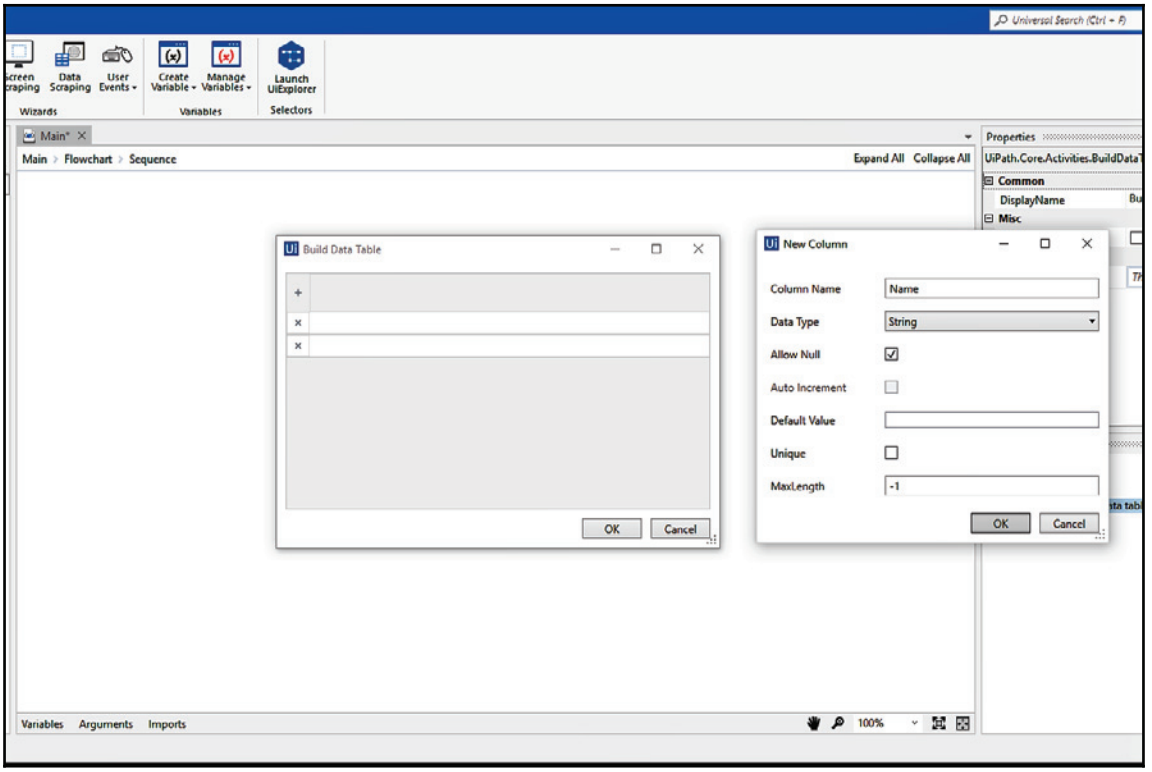
Let us see, how to build a data table can be built. First, create an empty project. Give it a proper name:

1. Drag and drop a **Flowchart** activity on the Designer panel. Also, drag and drop a **Sequence** activity and set it as the **Start** node.
2. Double click on the **Sequence** and drag and drop the **Build Data Table** activity inside the **Sequence** activity.

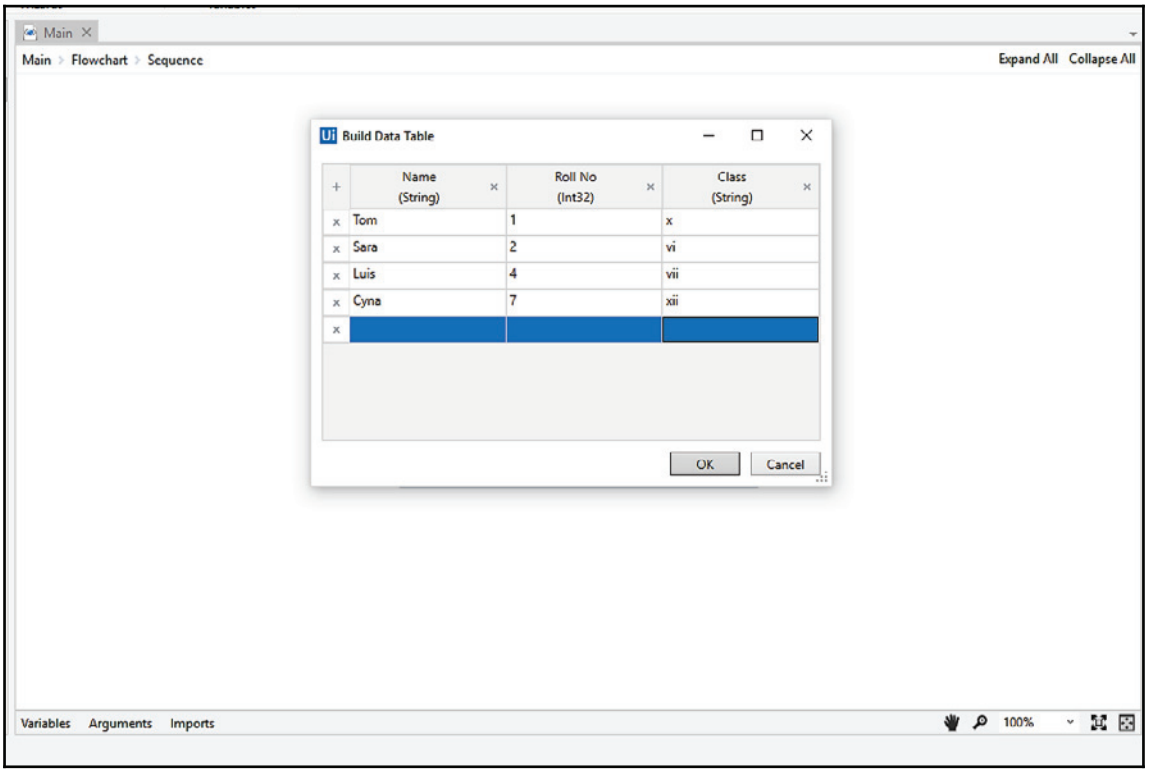
3. Click on the **Data Table** button. A pop-up window will appear on the screen. Remove both the columns (auto generated by the **Build Data Table** activity) by clicking on the Remove Column icon:



4. Now, we will add three columns by simply clicking on the + symbol. Specify the column names and select the appropriate data types from the drop-down list. Click on the **OK** button. We will add column `Name` of **String** Data Type, `Roll_No` of **Int32** type and finally Class of string type:

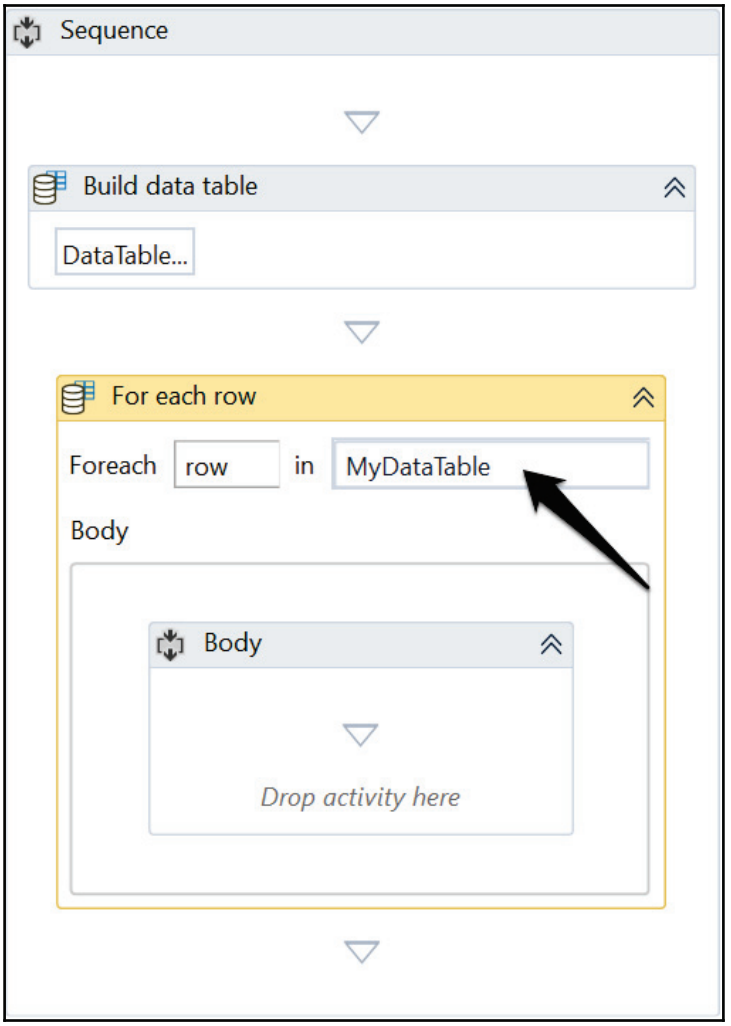


Now enter some random values just to insert the data into the rows:

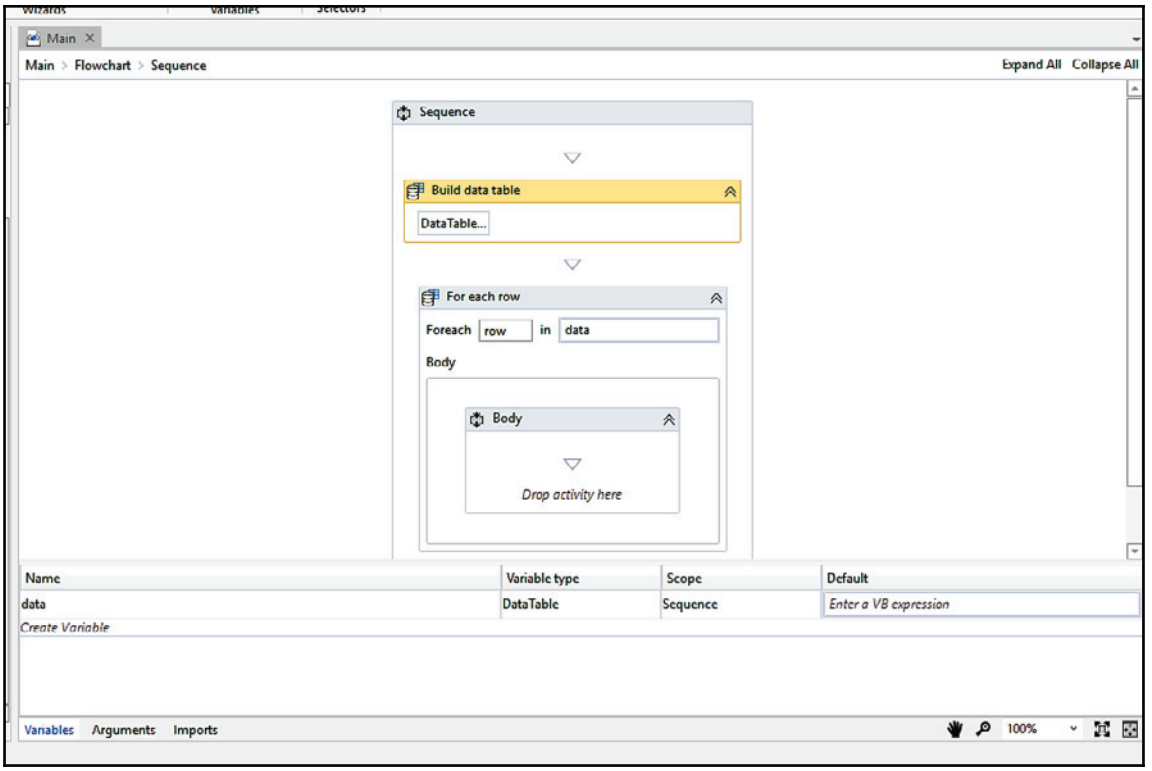


Click on the **OK** button and our data table is ready. We have to iterate over the data table's rows to make sure everything works correctly.

5. In order to store the Data Table created by **Build Data Table** activity, we have to create a data table variable `MyDataTable` of **DataTable** type and in order to store the result of the data table that we have dynamically built. Also, specify assign the **Output** property of the **Build Data Table** activity with this variable. Specify the data table variable's name there.
6. After our data table is ready, we will iterate the data table's rows to make sure everything works correctly. Drag and drop the **For each row** activity from the **Activities** panel inside the **Sequence** activity. Specify the data table variable's name (`MyDataTable`) in the expression text box of the **For each row** activity:

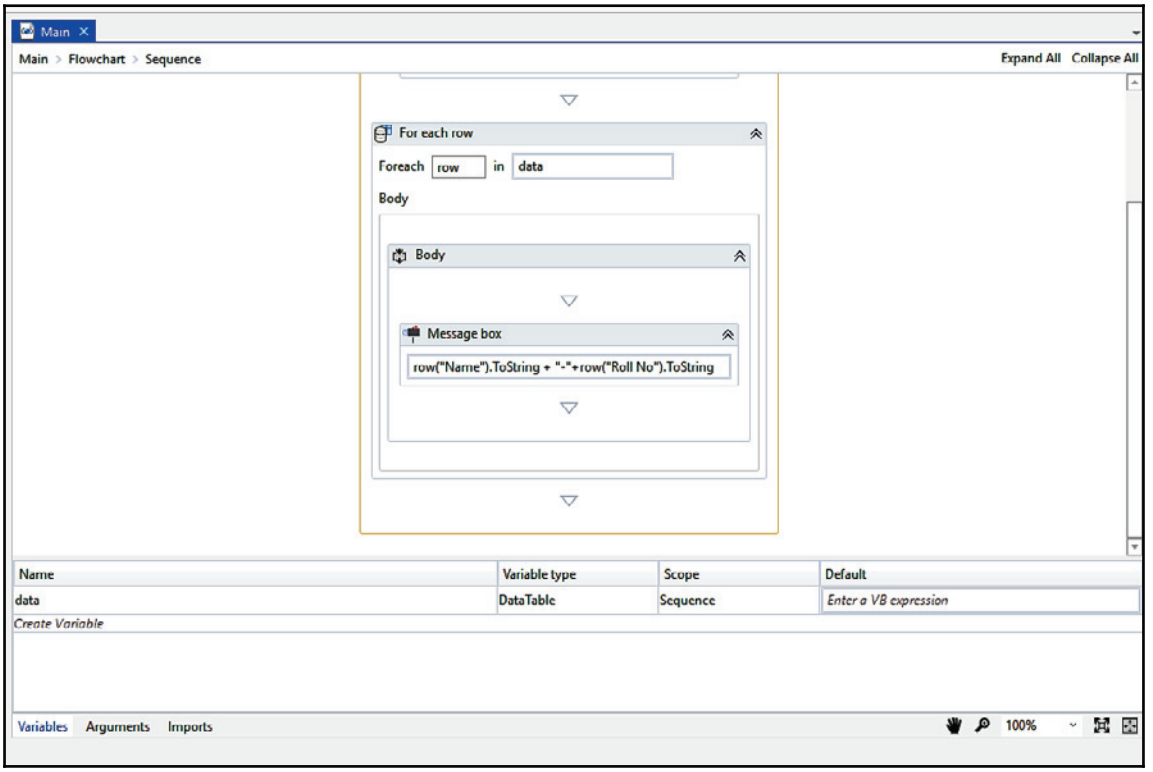

Sequence
Build data table
DataTable...
For each row
Foreach
row
in
MyDataTable
Body
Body
Drop activity here

6. Drag and drop the **For each row** activity from the **Activities** panel inside the **Sequence** activity. Specify the data table variable's name in the expression text box of the **For each row** activity:



For each and **For each row** are two different activities. **For each** is used to iterate over the collections, while the **For each row** activity is used to iterate over the data table rows.

7. Drag and drop a **Message box** activity inside the **For each row** activity. In the **Message box** activity, Inside the message box we have to write following string: `row("Name").ToString +"-"+ row("Roll_No").ToString + "-"+row("Class").ToString. row` the variable which holding data for the data row in each iteration:

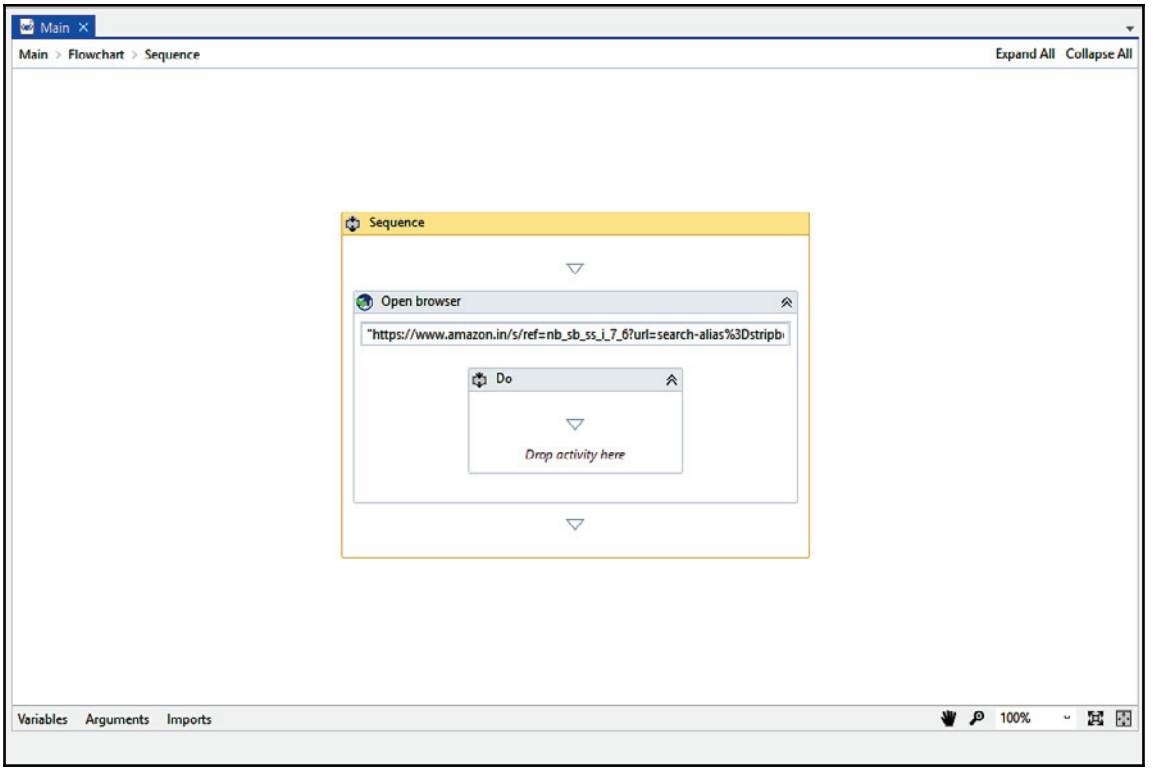


This row variable contains all the columns of a particular row. Hence, we have to specify which column value we want to retrieve by specifying the column name. Instead of the column name, we can also specify the column index (the column index always starts from zero). Hit the **Run** button to see the result.

Building a data table using data scraping (dynamically)

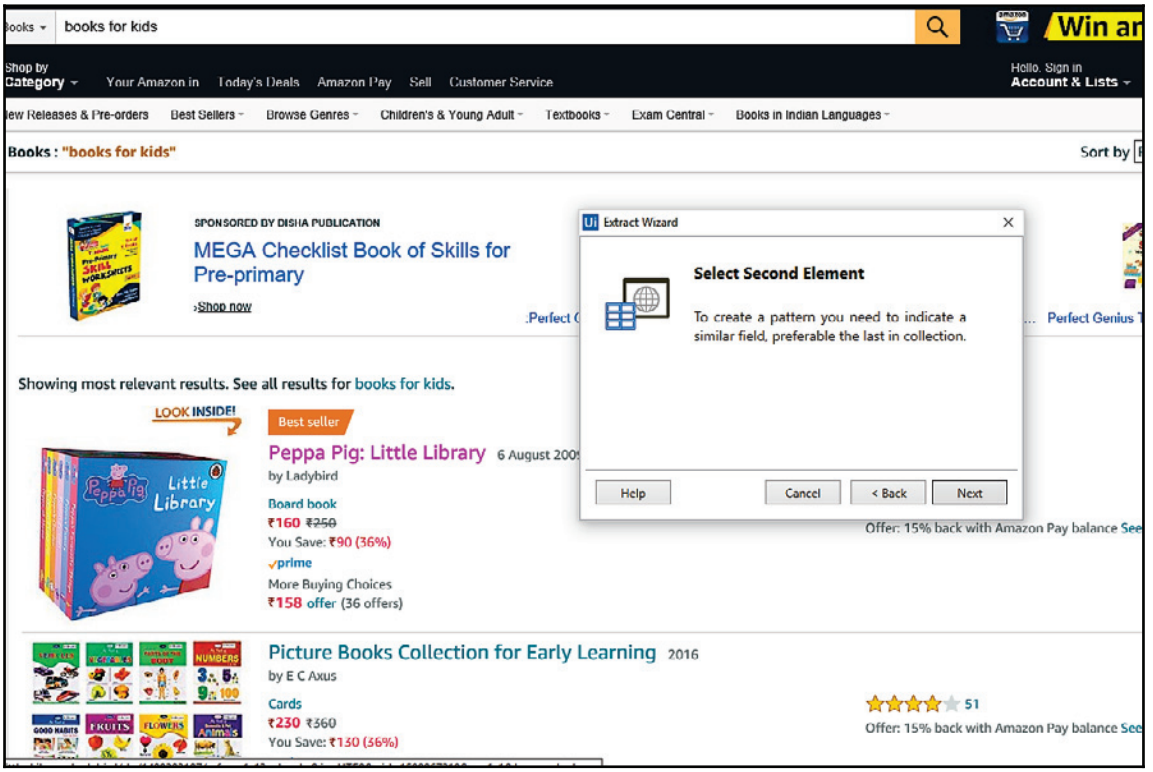
Using data scraping, we can build the data table at runtime. Let us consider an example of extracting data from Amazon's website. Perform the following steps:

1. Drag and drop the **Flowchart** activity from the **Activities** panel, and drag and drop the **Sequence** activity inside the **Flowchart** activity.
2. Double-click on the **Sequence** activity.
3. Drag and drop the **Open Browser** activity inside the **Sequence** activity. Specify the URL in the text box:

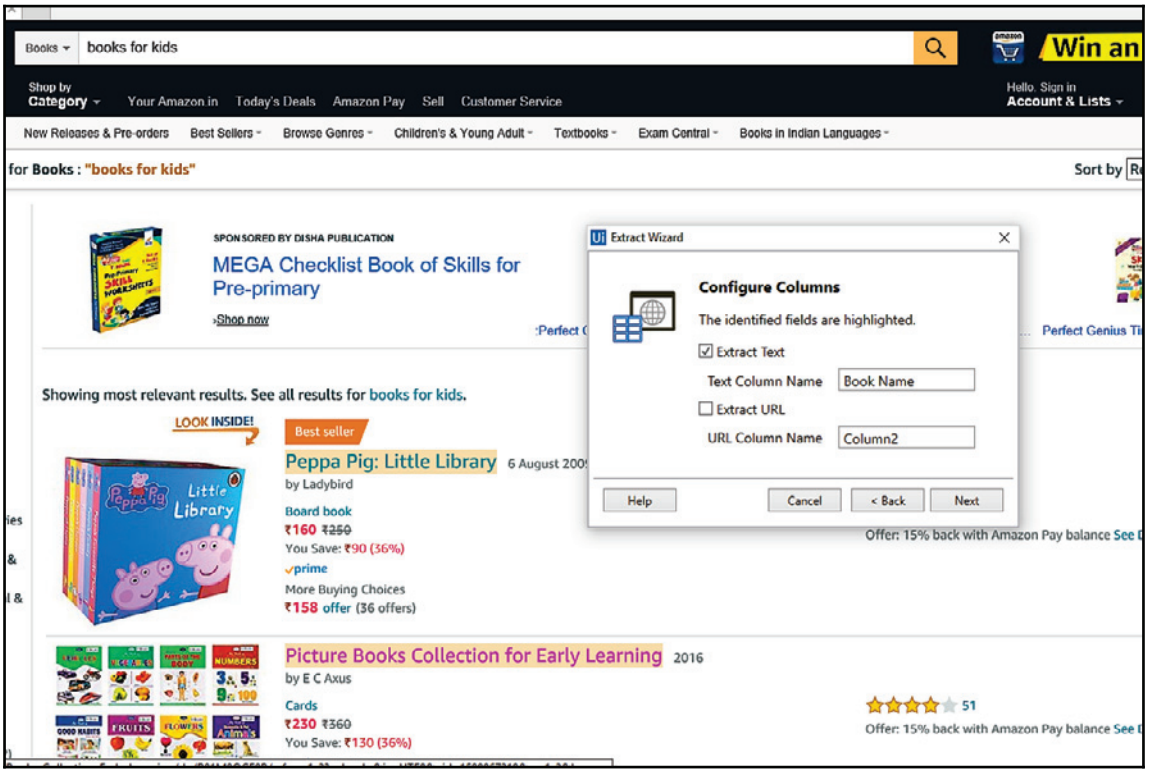


(URL: `https://www.amazon.in/s/ref=nb_sb_ss_i_7_6?url=search-alias%3Dstripbooksfield-keywords=books+for+kidssprefix=books+%2Cstripbooks%2C322crid=2OWJE9AMZYS06`)

4. Click on the **Data Scraping** icon on the top left corner of UiPath Studio. A window will pop up. Click on the **Next** button.
5. Now, there will be a pointer pointing to the UI elements of the web page. Click on the name of the book:

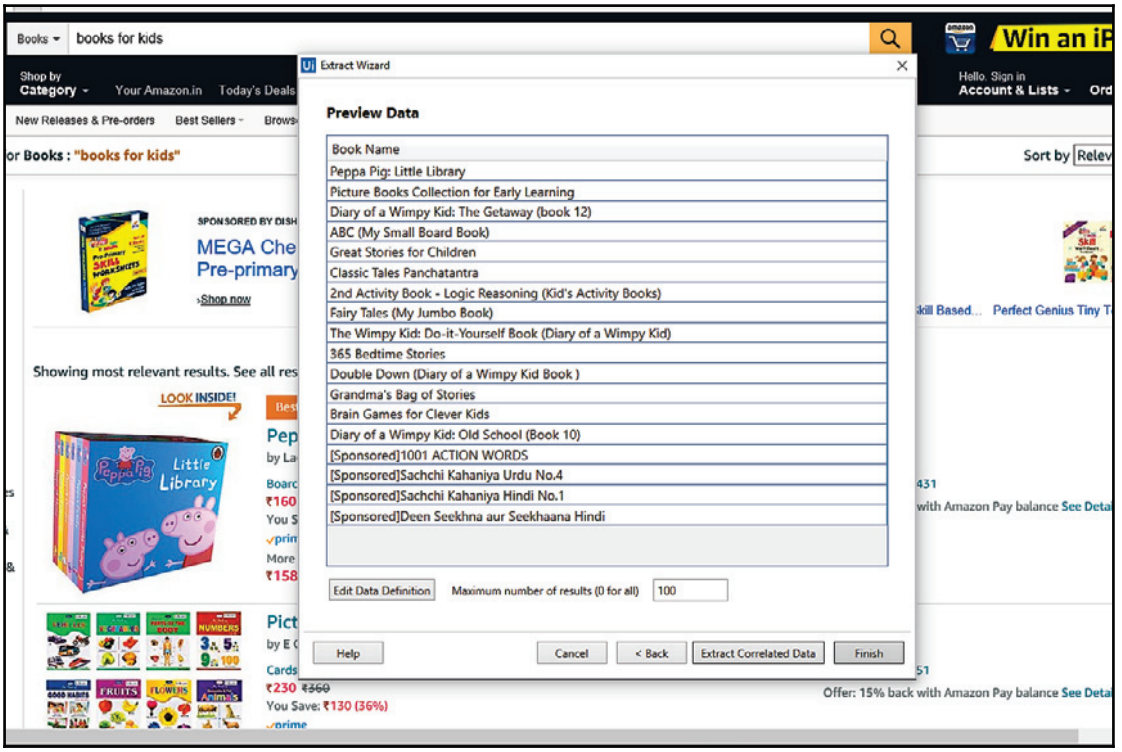


It will ask you to point to a second similar element on the web page:

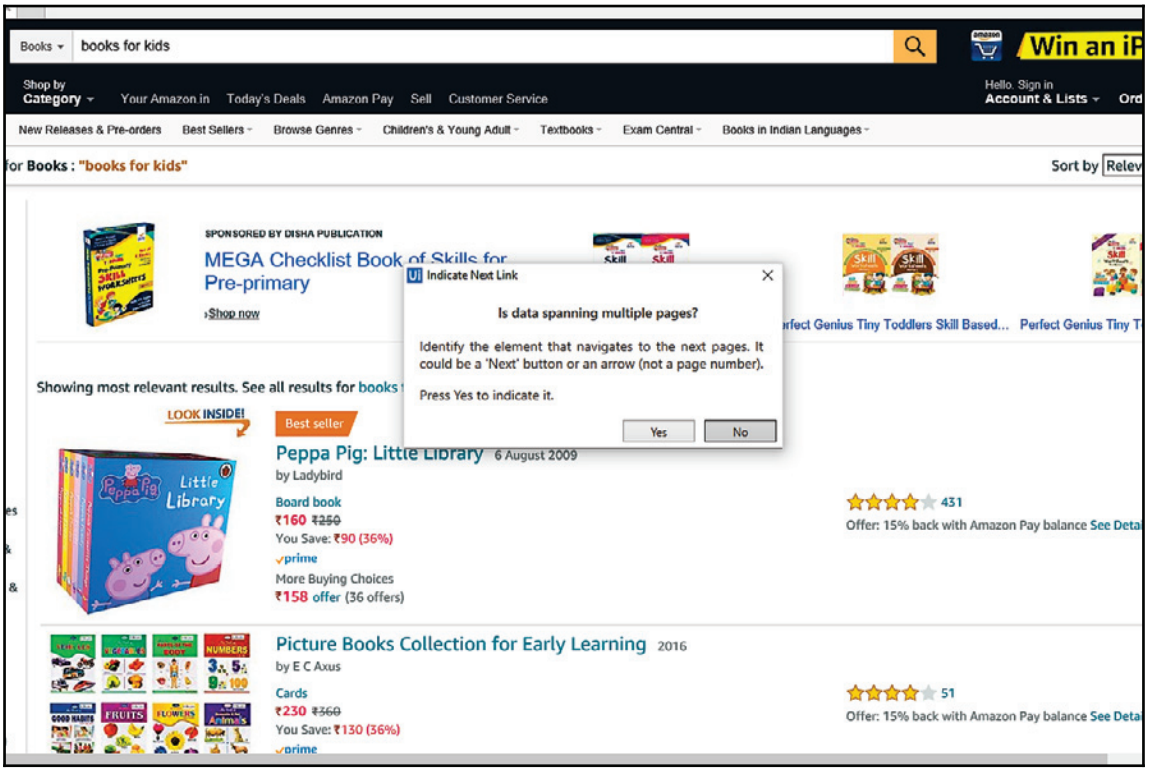


6. Point to a second similar element on that web page. Specify the name that you want to give for that extracted data column. (It will become the column name of the extracted data). Click on the **Next** button.
7. A list of names will appear in a separate window.

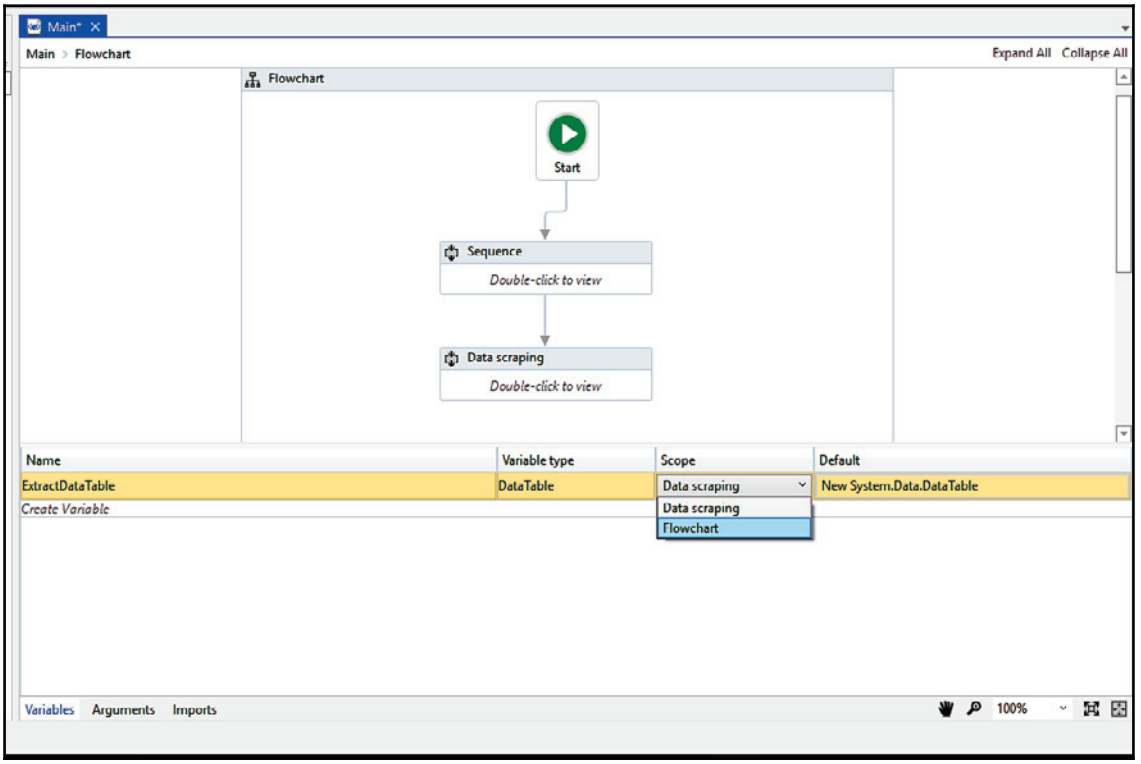
If you want to extract more information, then click on the **Extract correlated data** button and repeat the same process once again (just as we extracted the name of the book from Amazon's website). Otherwise, click on the **Finish** Button:



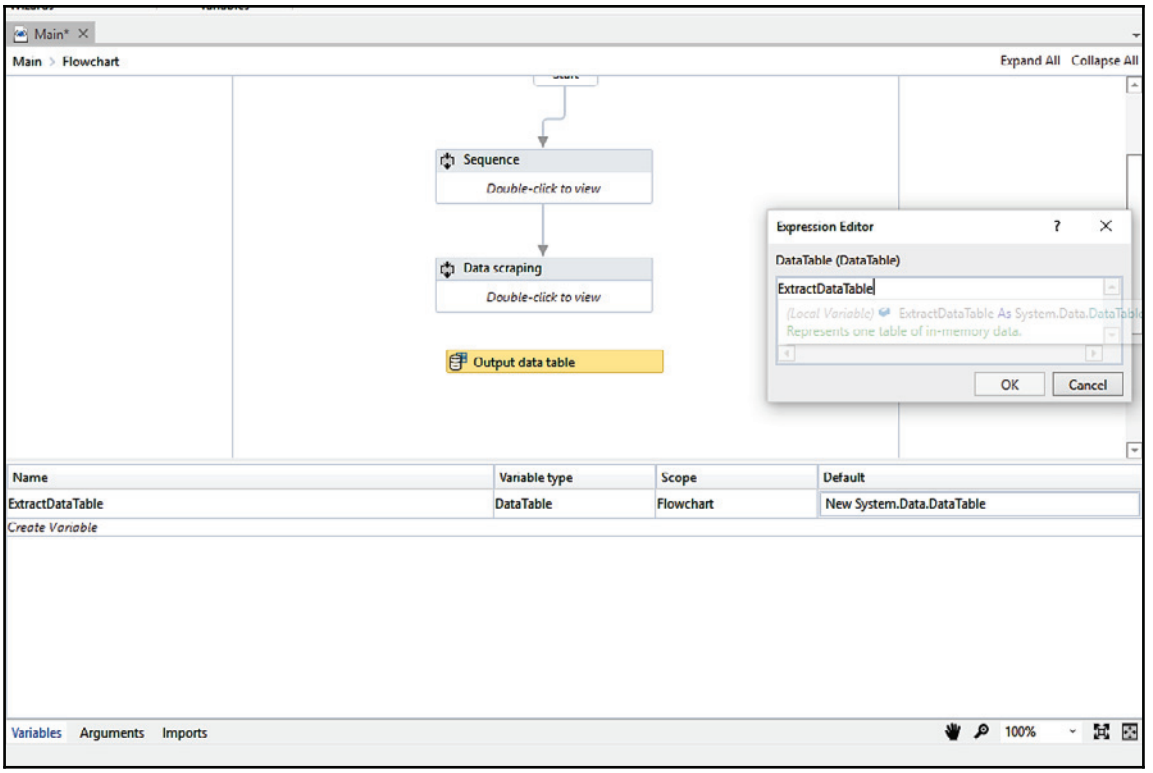
8. It will ask you to locate the next page's button/link. If you want to extract more information about the product and it spans across multiple pages, then click on the **Yes** button and point to the next page's button/link. Then, click on it. If you want to extract only the current page's data, click on the **No** button, (you can also specify the number of rows that you want to extract data from: By default it is 100):



9. Data scraping generates a data table. (In this case, `ExtractedDataTable` is generated.) Change the scope of `ExtractedDataTable` to the **Flowchart** so that it is accessible within the **Flowchart** activity:

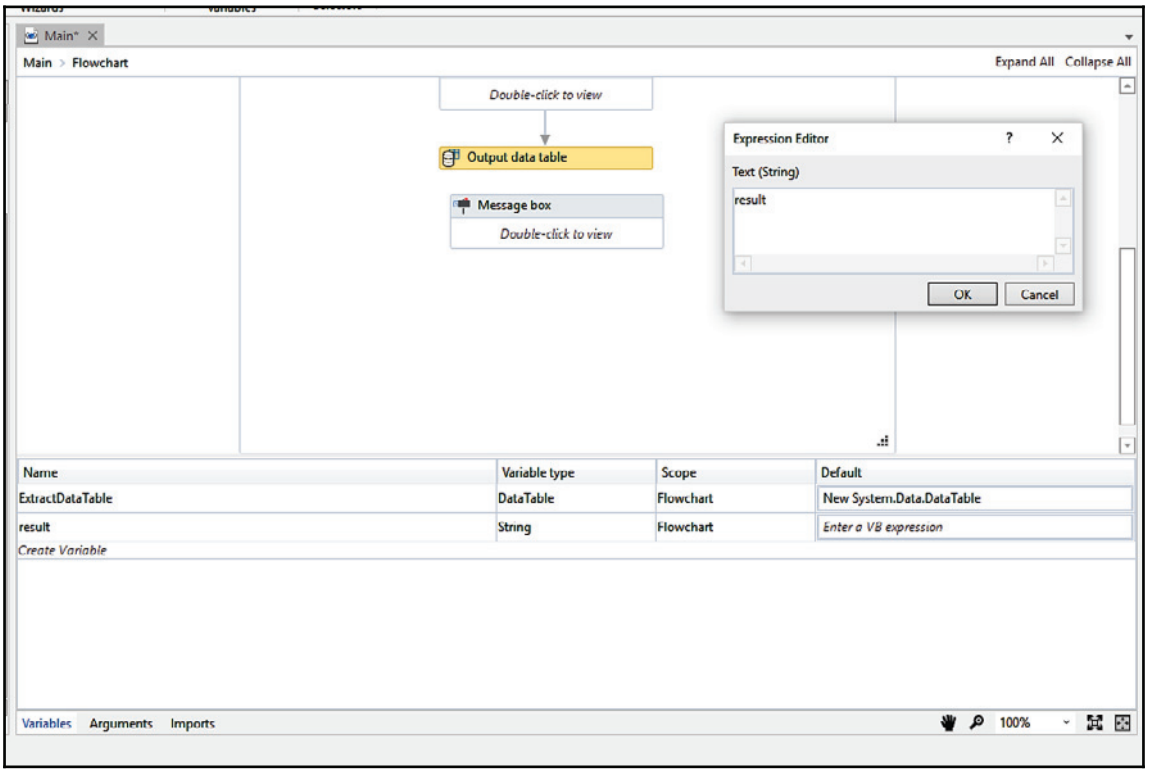


10. Drag and drop the **Output data table** activity on the **Flowchart**. Set the **Output** property of the **Output data table** activity as: `ExtractedDataTable`:



11. Connect the **Output data table** activity to the **Data Scraping** activity. Drag and drop the **Message box** activity on the Designer window. Also create a string variable to receive the text from the **Output data table** activity (in our case, we have created a `result` variable).

Specify the text property of the **Output data table** activity as the `result` variable to receive the text from the **Output data table**:



12. Connect the **Message box** activity to the **Output data table** activity. Double-click on the **Message box** and specify the text property as the `result` variable (the variable that you created to receive the text from the **Output data table** activity).
13. Hit the **Run** button and see the result.

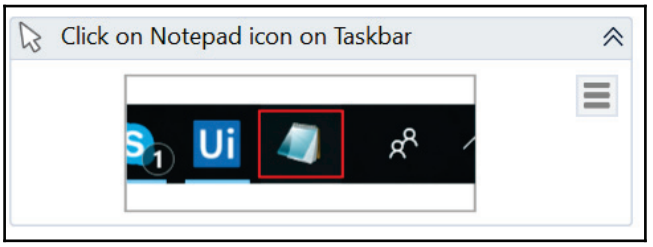
Clipboard management

Clipboard management involves managing the activities of the clipboard, for example, getting text from the clipboard, copying selected text from the clipboard, and so on.

Let us see an example of getting text from the clipboard.

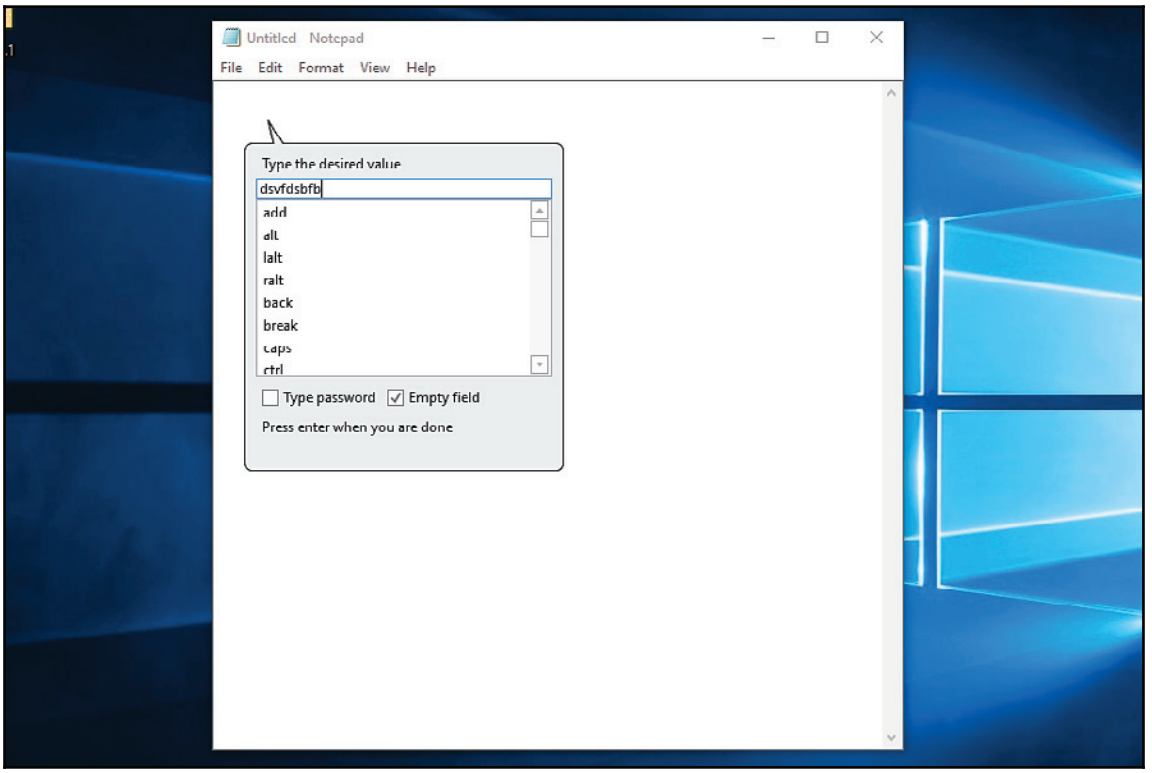
In this example, we will use Notepad. We will open Notepad, write some data into it, and then copy the data to the clipboard. We will then extract the data from the clipboard:

1. Drag and drop a **Flowchart** activity from the **Activities** panel.
2. Click on the **Recording** icon on the top of UiPath Studio. A drop-down menu will appear with the options, **Basic**, **Desktop**, **Web**, and **Citrix**, indicating the different types of recording. Select **Desktop** and click on **Record**.
3. Click on **Notepad** to open it. A Notepad window will pop up:

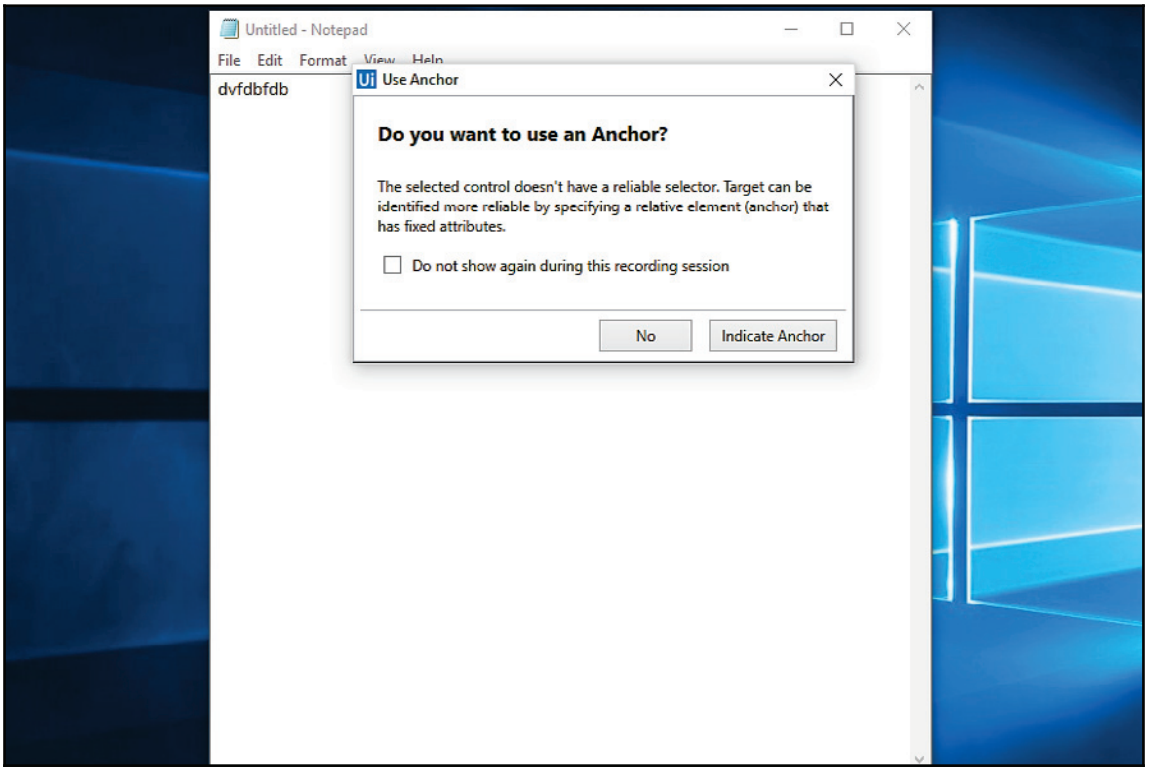


4. Click on the text area of Notepad. Type into the dialog box and check the empty field. (Checking the empty field will erase all existing data in Notepad before writing any new data.) Press *Enter*.

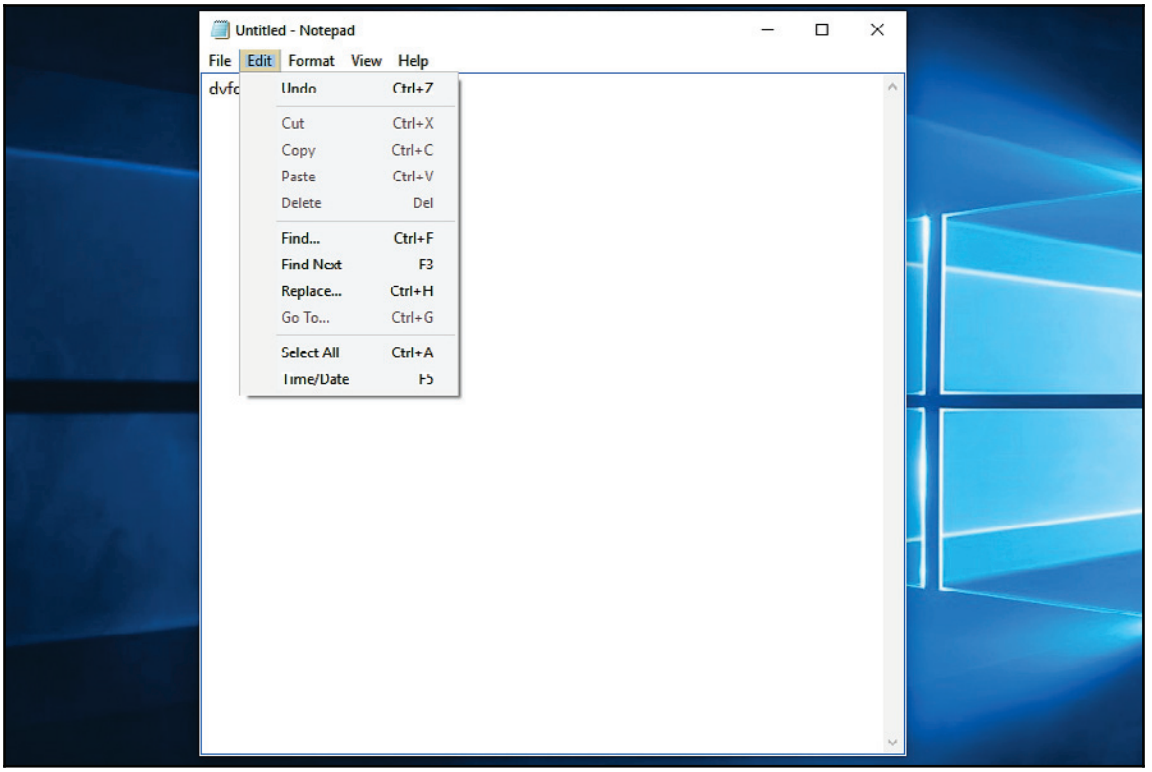
Data will be written on the Notepad text area:



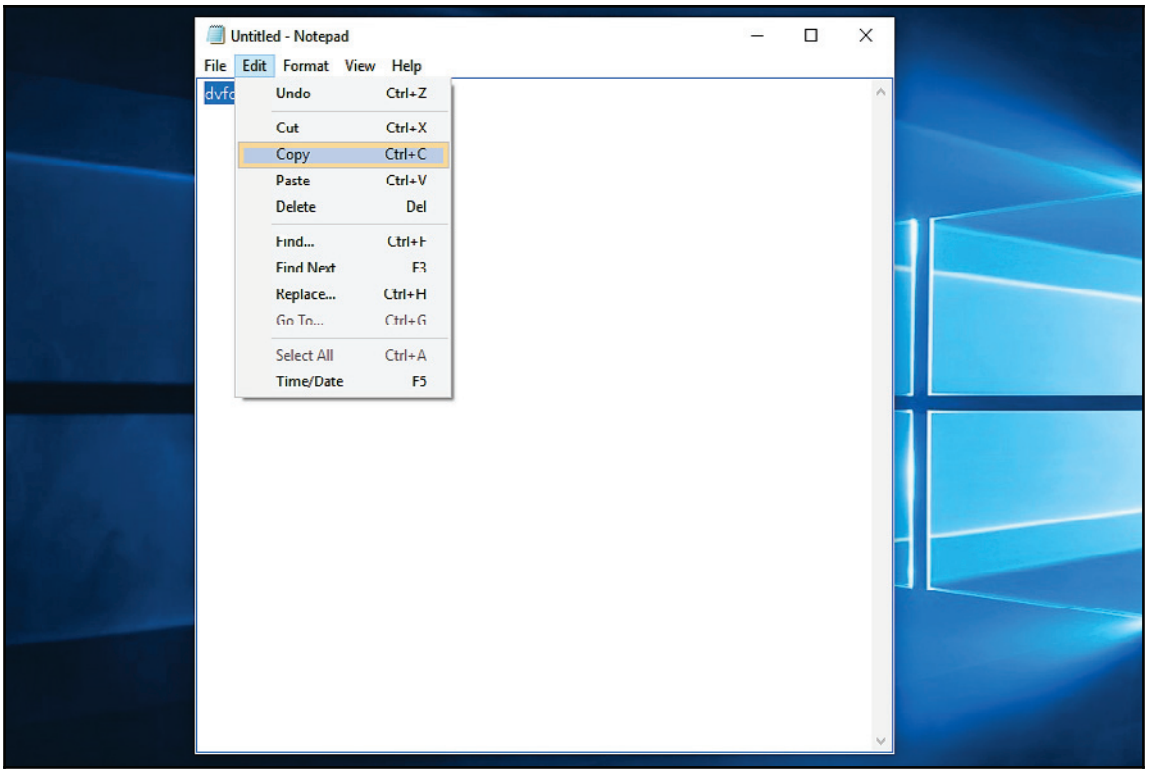
5. Click on the **Edit** button. A pop-up window will appear asking you whether you want to use an anchor. (An anchor is a relative element of the current `{focused}` element.) As you can see clearly, the anchor element of the **Edit** button can be the **File** or **Format** button. In this case, we have chosen the **Format** button:



6. Then, it will automatically start recognizing the **Edit** button. Choose the **Select all** option from the drop-down list:



7. Once again, click on the **Edit** button. It will again ask you to indicate the anchor element. Indicate the anchor button and the **Edit** button will be highlighted, giving you a drop-down box. Select the **Copy** option:

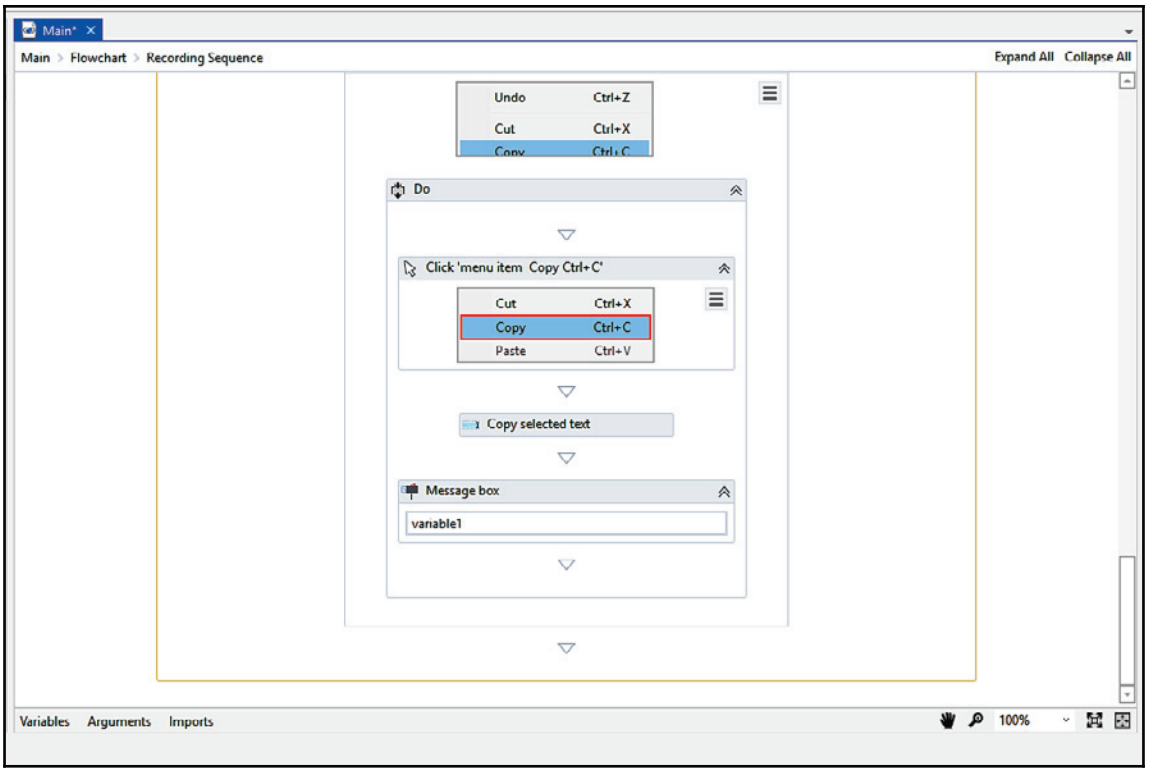


This copied text is now stored in the clipboard.

We can use the **Get from clipboard**, and **Copy selected text** activities to copy the text that is stored in the clipboard.

We will use the **Copy selected text** activity.

8. Double-click on the **Recording sequence** that is generated by the recording. Scroll down and drag and drop the **Copy selected text** and **Message box** activities inside the **Recording sequence**:



9. Create a variable of type **String** to store the output value of **Copy selected text**. This variable will receive the required text from the clipboard with the **Copy selected text** activity. Now, specify the newly created variable in the **Output** property of the **Copy selected text** activity. This will be the required selected text that we have copied into the clipboard.
10. Specify the string variable in the text property of the **Message box** activity.
11. Hit the **Run** button to see the result.

File operation with step-by-step example

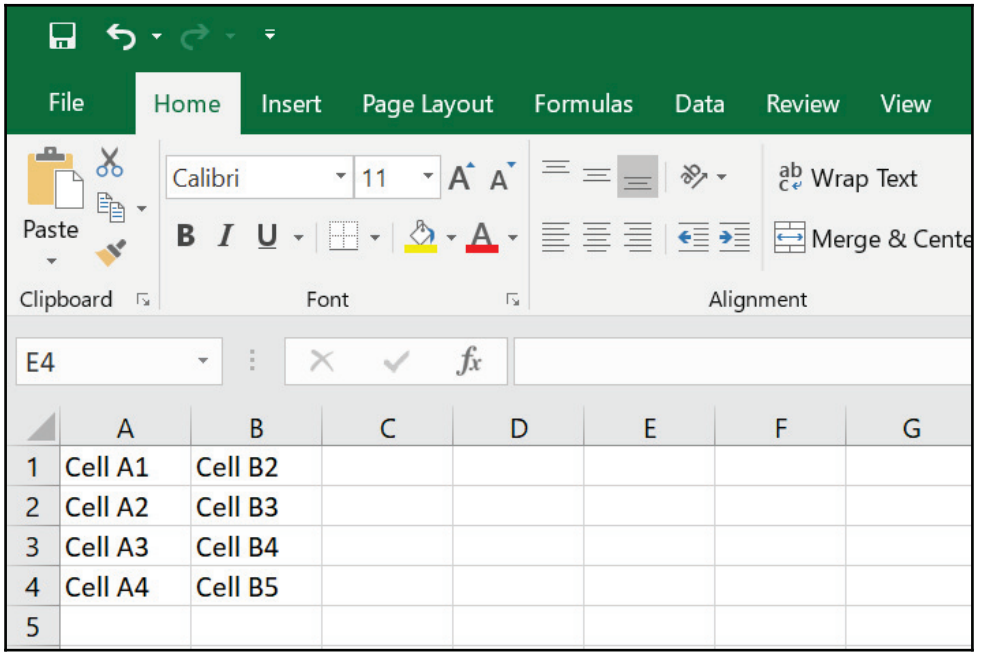
In this module, we are going to operate on Excel file. The following are the methods that are frequently used with an Excel file:

- Read cell
- Write cell
- Read range
- Write range
- Append range

Once you get familiar with these methods, it will become very easy for you to use other methods too.

Read cell

This is used to read the value of a cell from an Excel file. We have a sample Excel file that we will use in this example:

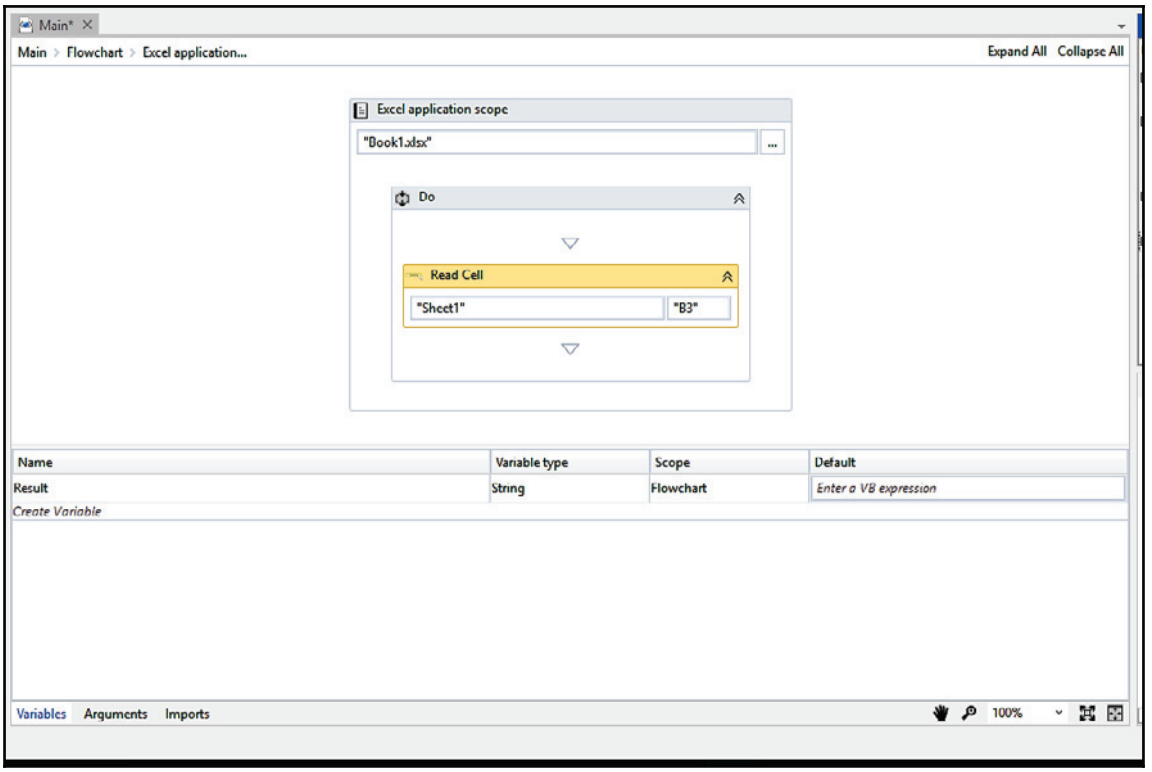


Suppose we have to read the value of the **B3** cell:

1. Drag and drop a **Flowchart** activity on the main Designer panel. Also, drag and drop an **Excel application scope** inside the **Flowchart**. Connect it to the **Start** node. Double click on Excel application scope.

It is a good practice to use the **Excel application scope** when using Excel activities inside our project.

2. Drag and drop the **Read Cell** activity inside the **Excel application scope** activity. Specify the range value in the cell text box of the **Read Cell** activity. Create a variable of type string to hold the result produced by the **Read Cell** activity. In our case, we have created a `Result` variable. Specify the **Output** property of the **Read Cell** activity by providing the variable's name that we have created:



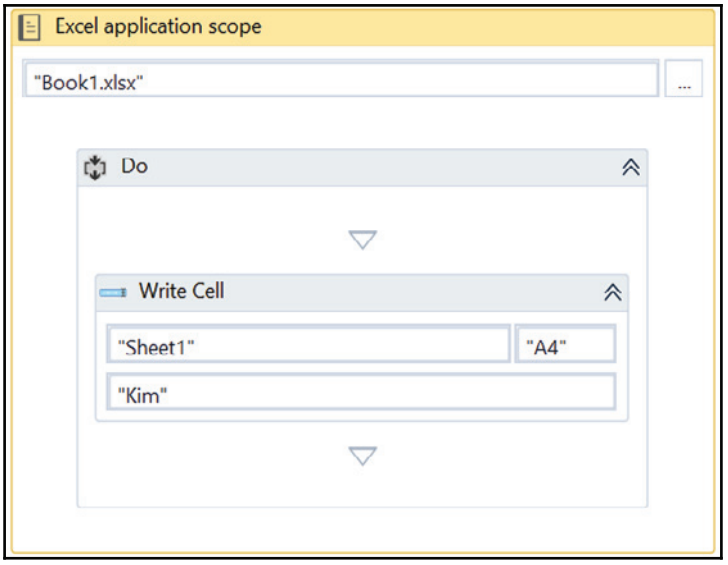
3. Drag and drop a **Message box** activity inside the **Excel application scope** activity and specify the string variable's name (which we created earlier) in the expression box of the **Message box** activity.

That's it. Press *F5* to see the result.

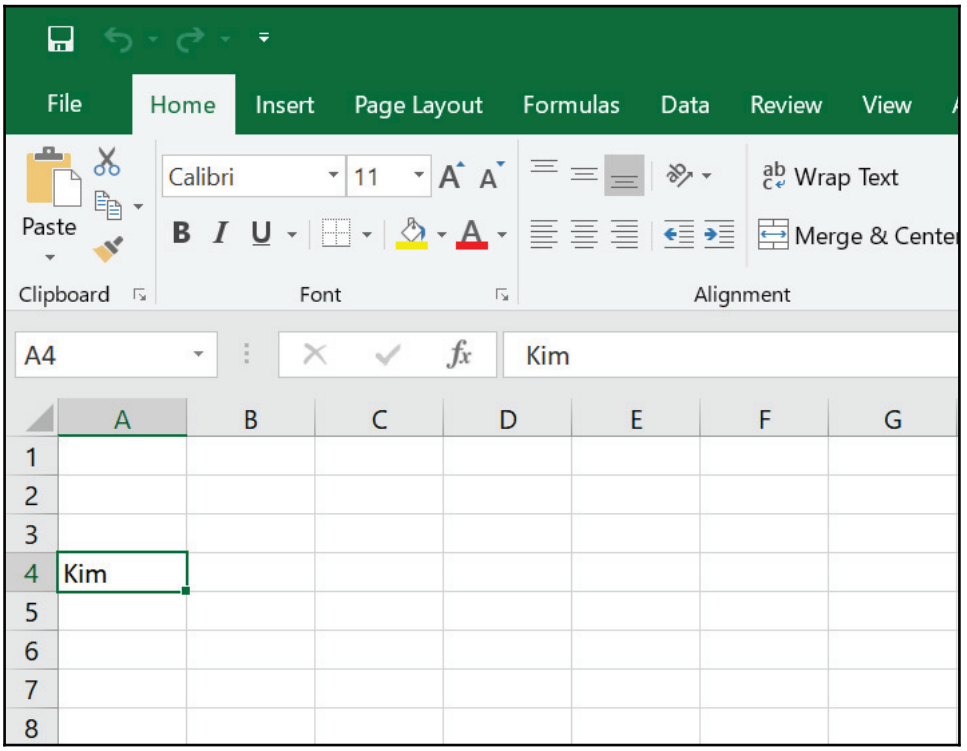
Write cell

This activity is used to write a value in a cell of an Excel file:

1. Drag and drop a **Flowchart** activity on the main Designer panel. Also, drag and drop an **Excel application scope** inside the **Flowchart** activity. Connect it to the **Start** node.
2. Drag and drop a **Write Cell** activity inside the **Excel application scope**. Specify the cell value in which we want to write in the **Range** property of the **Write Cell** activity. Also, specify the value of the **Value** property:



Press *F5* and see the result. Open the Excel file to see the changes:

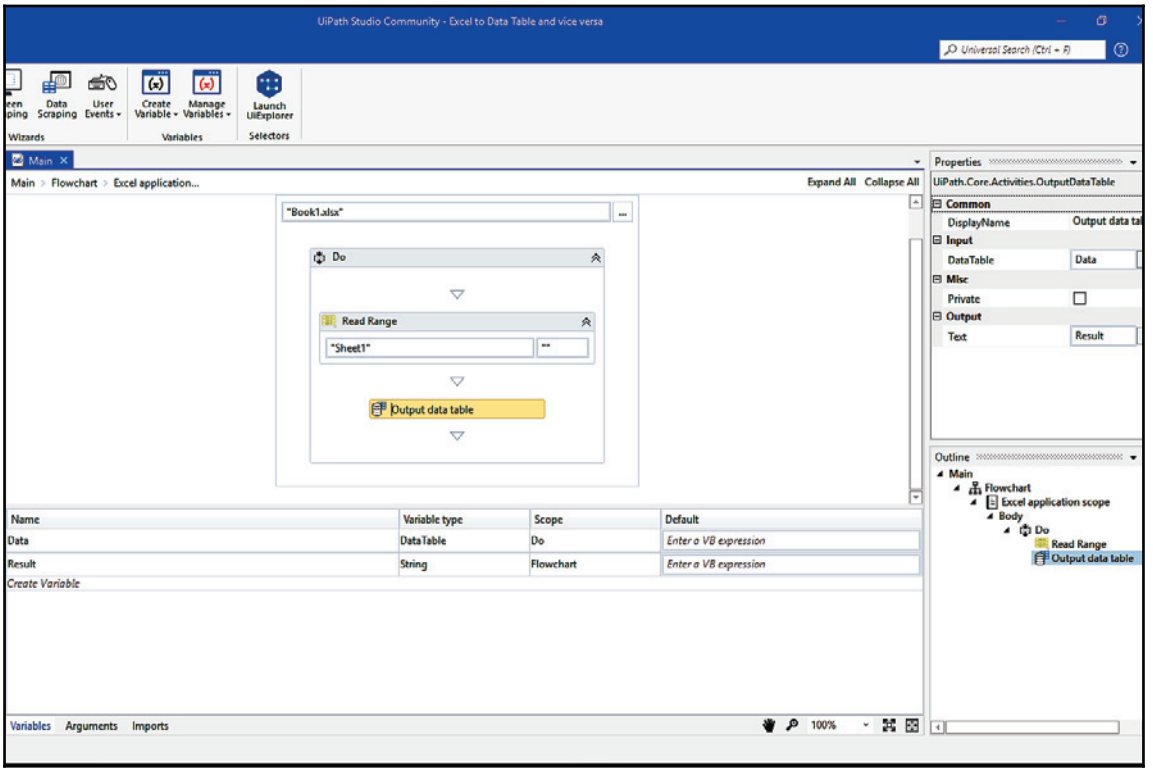


Read range

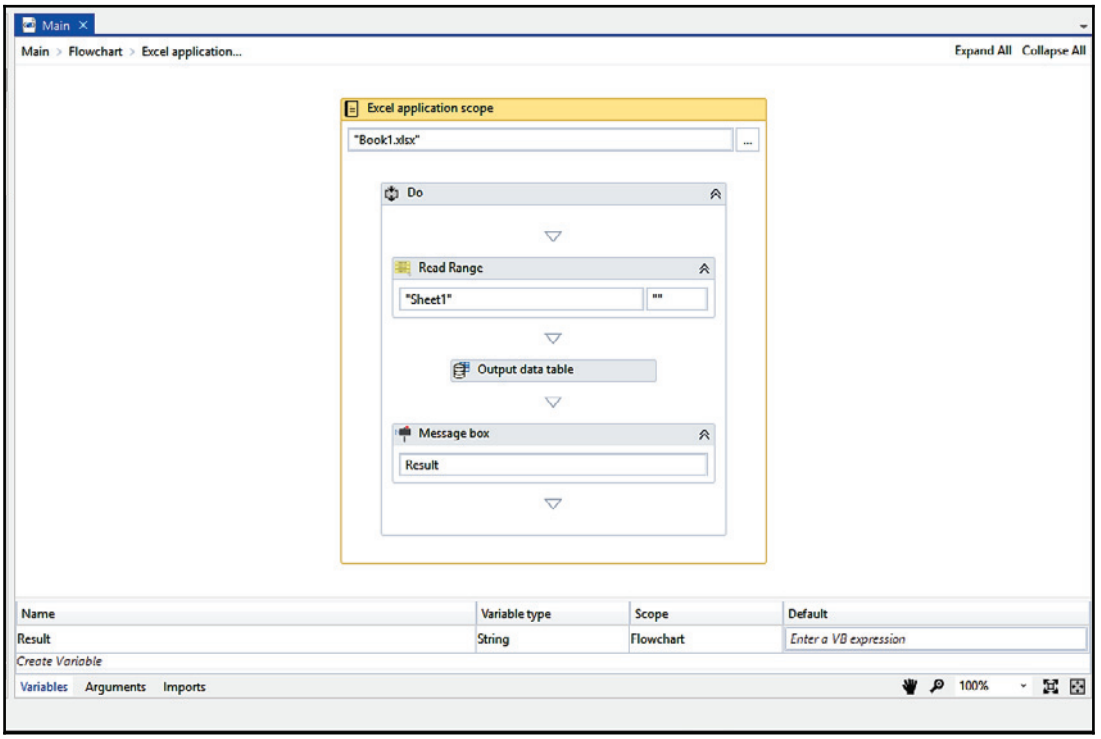
This is used to read the value up to the specified range. If the range parameter is not specified, it will read the entire Excel file:

1. Drag and drop a **Flowchart** activity on the main Designer panel. Also, drag and drop an **Excel application scope** inside the **Flowchart** activity. Connect it to the **Start** node.
2. Drag and drop a **Read Range** activity inside the **Excel application scope** activity. The **Read Range** activity produces a data table. We have to receive this data table in order to consume it. We need to create a data table variable and specify it in the **Output** property of the **Read Range** activity.

3. Drag and drop an **Output Data Table** activity inside the **Excel application scope** activity. Now, we have to specify two properties of the **Output Data Table** activity: **Data Table** property and text property. The **Data Table** property of the **Output Data Table** activity is used to convert the data table into a string format. The text property is used to supply its value in a string format. We have to receive this value in order to consume it. For this, let us create a variable of type string. Give it a meaningful name (in our case, it is **Result**):



4. Drag and drop a **Message box** activity inside the **Excel application scope** activity. Also, specify the string variable's name that we created earlier inside the **Message box** activity:

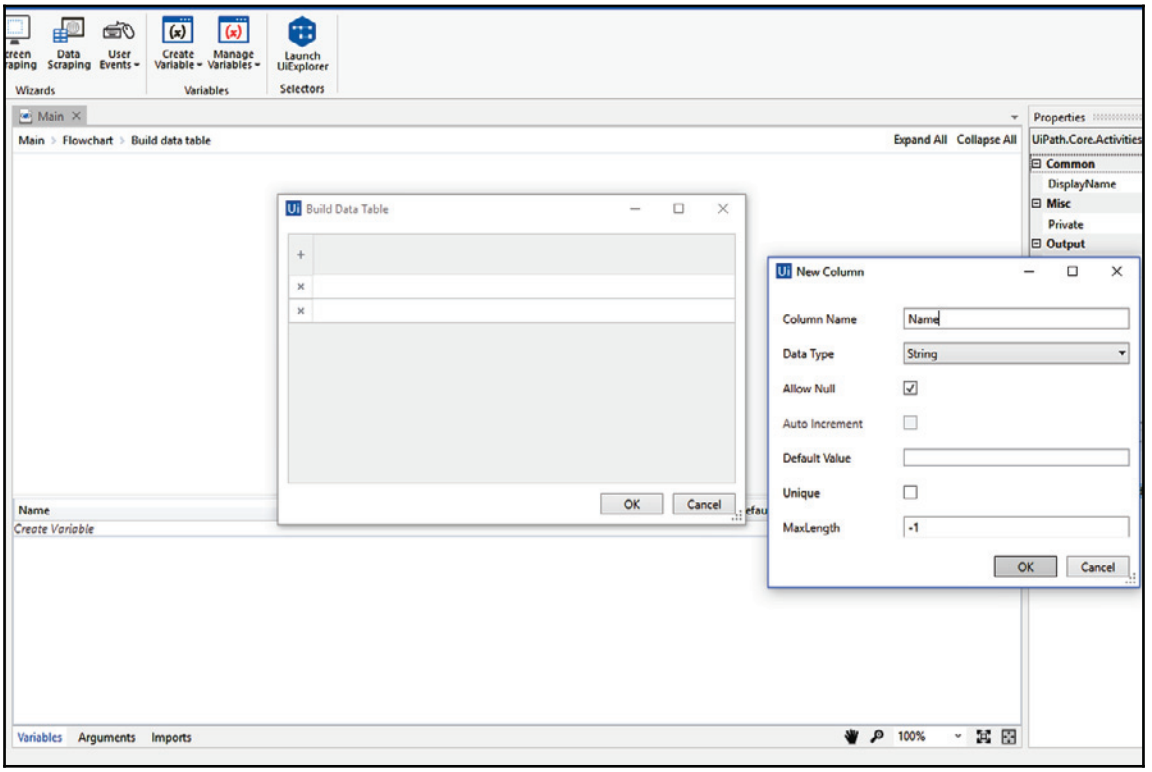


That's it. Press *F5* to see the result. A window will pop up displaying your Excel file data.

Write range

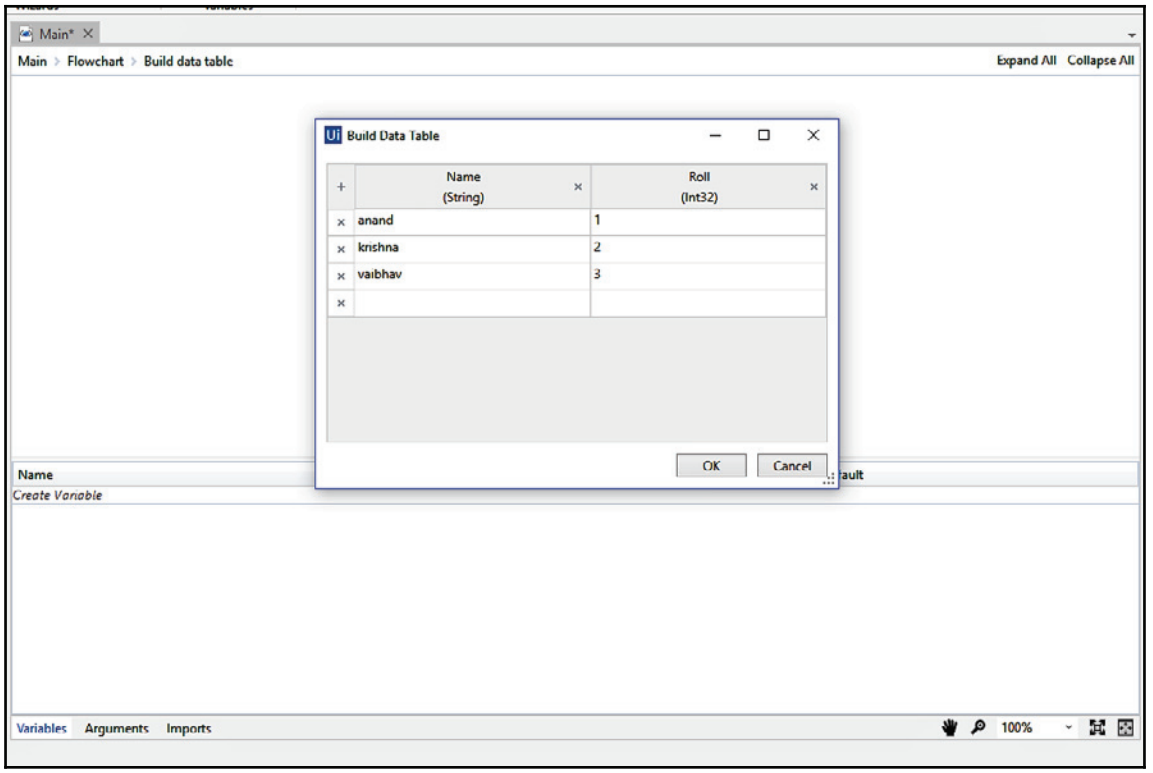
This is used to write a collection of rows into the Excel sheet. It writes to the Excel file in the form of a data table. Hence, we have to supply a data table:

1. Drag and drop a **Build data table** activity from the **Activities** panel. Double-click on this activity. A window will pop up. You will notice that two columns have been generated automatically. Delete these two columns. Add your column by clicking on the **+** icon and specify the column name. You can also select your preferred data type. You are free to add any number of columns:



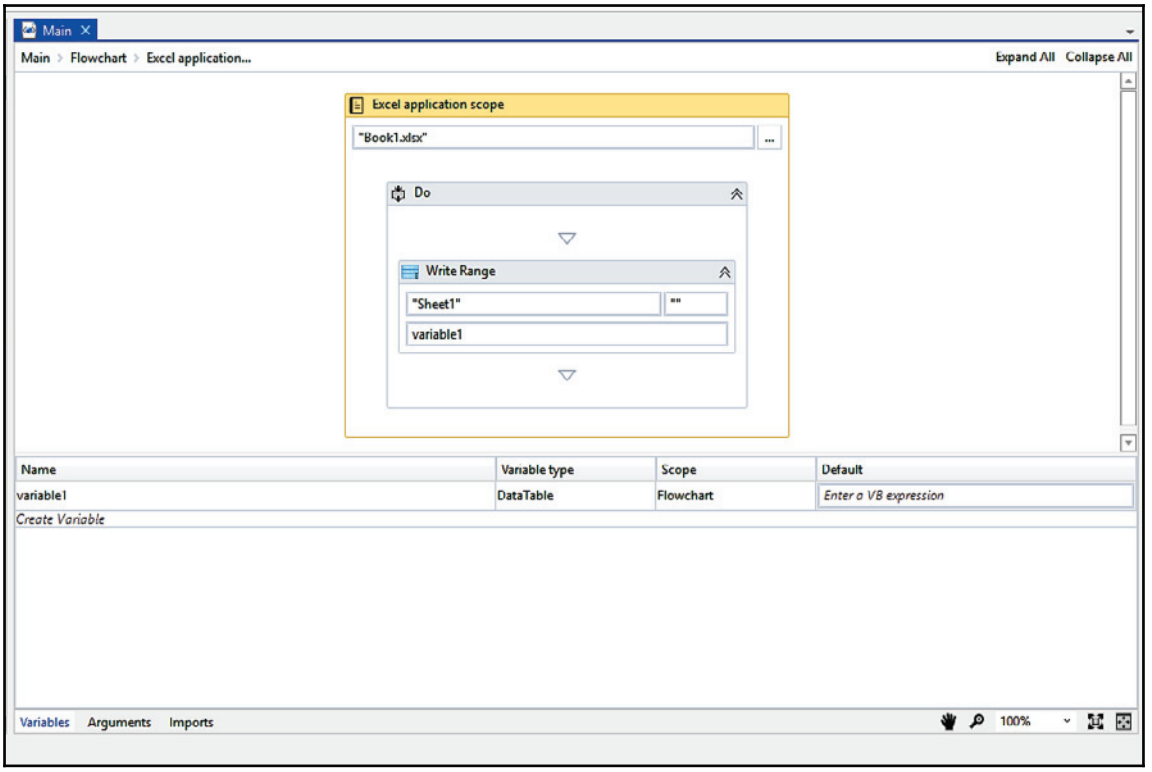
2. In this project, we are adding two columns. The procedure for adding the second column is almost the same. You just have to specify a name and its preferred data type. We have added one more column (Roll) and set the data type to **Int32** for the data table. We have also initialized this data table by providing some values in its rows.

   Create a variable of type data table. Give it a meaningful name. Specify this data table name in the **Data table** property of the **Build data table** activity. We have to supply this variable in order to get the data table that we have built:

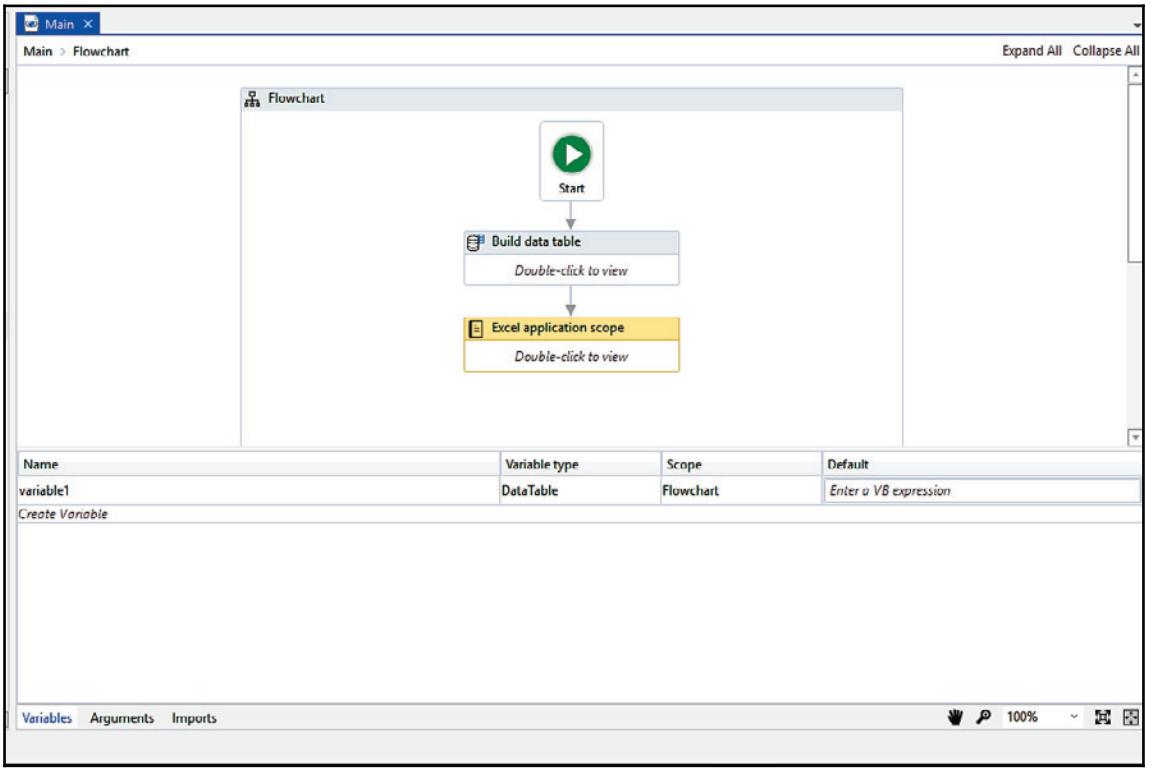


Our data table has been built successfully.

3. Drag and drop an **Excel application scope** inside the main Designer panel. You can either specify the Excel sheet path or manually select it. Connect this activity to the **Build Data Table** activity. Inside the **Excel application scope** activity, just drag and drop the **Write Range** activity:



4. Specify the data table variable name that we created earlier and set it as a **Data table** property inside the **Write Range** activity. We can also specify the range. In this case, we have assigned it as an empty string:



That's it. Hit the **Run** button or press *F5* to see the result.

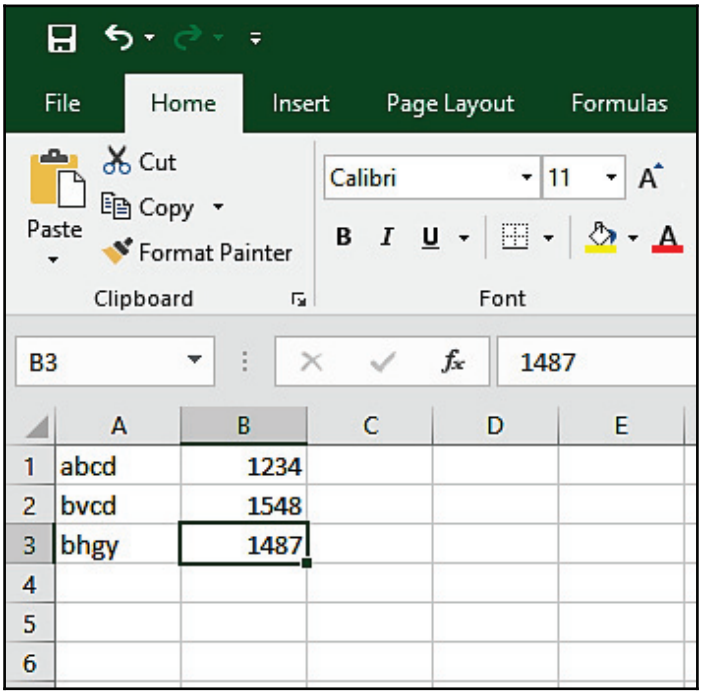
Append range

This is used to add more data into an existing Excel file. The data will be appended to the end.

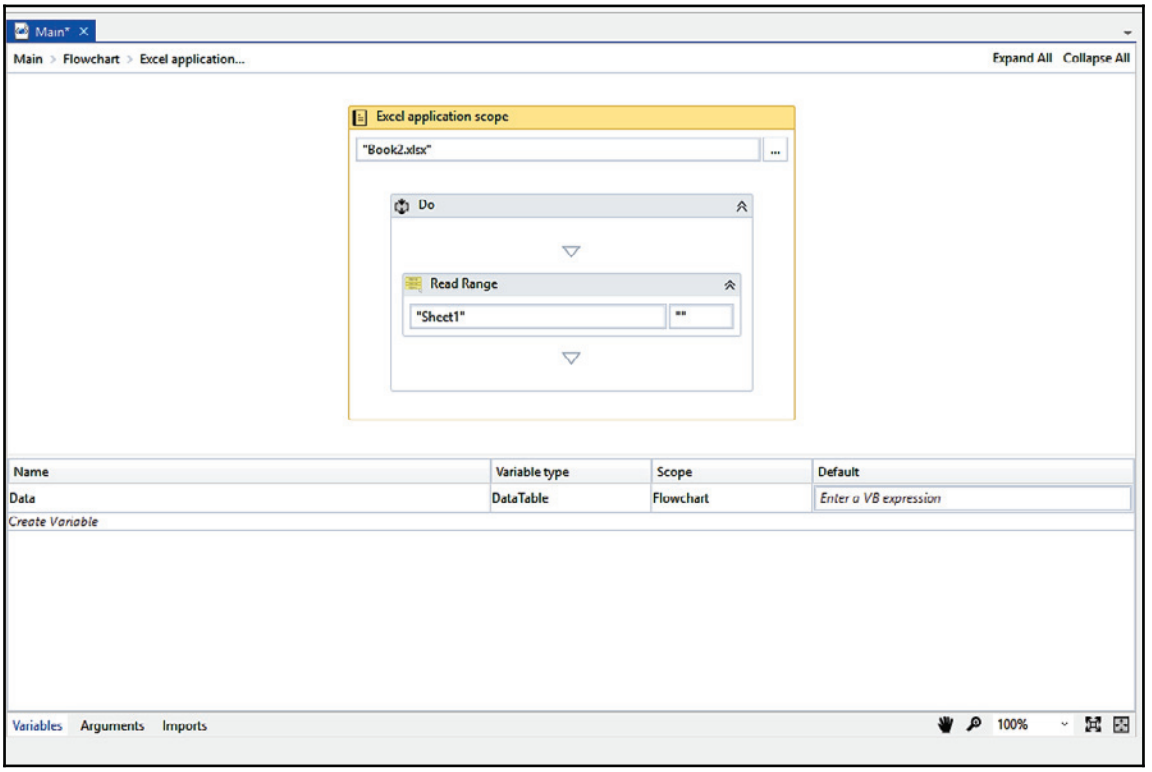
1. Drag and drop the **Flowchart** activity on the main Designer window. Also, drag and drop the **Excel application scope** inside the **Flowchart** activity. Connect it to the Start node.

   The **Append Range** activity requires a data table. In this program, we are going to use another sample Excel file, which has some raw data. Then, we will read this Excel file and append the data to another Excel file.

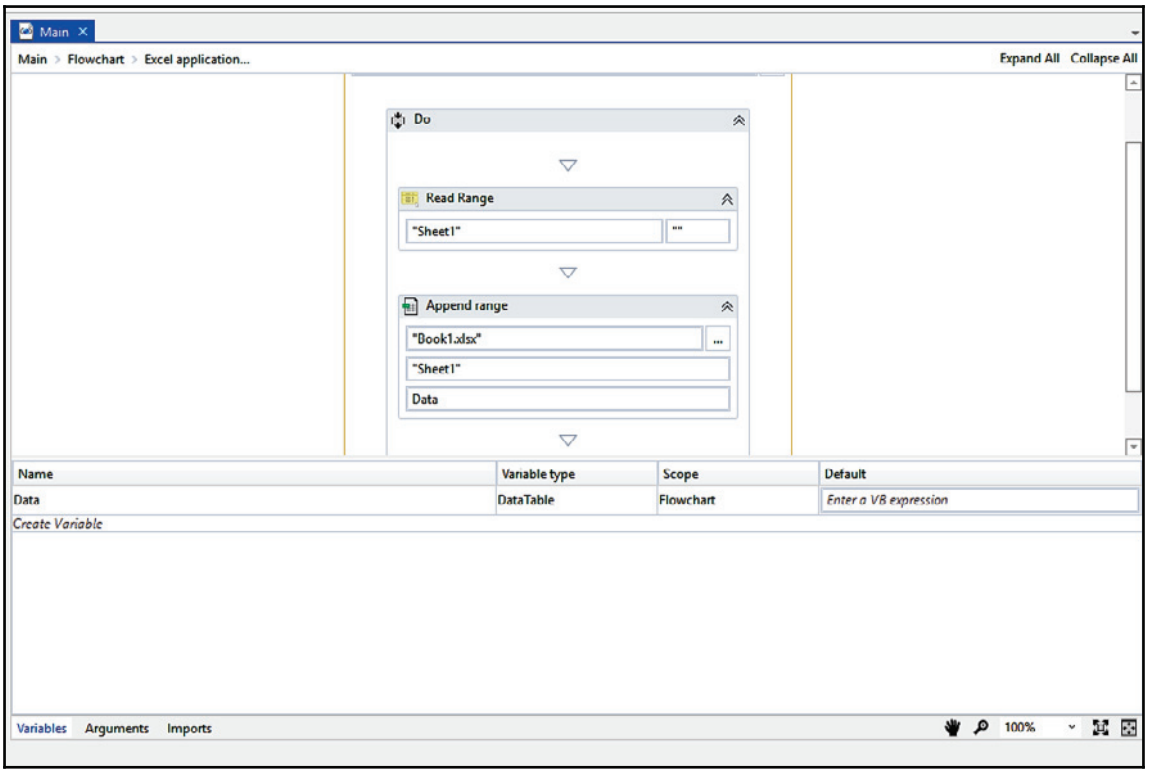
   First, we have to read its contents:



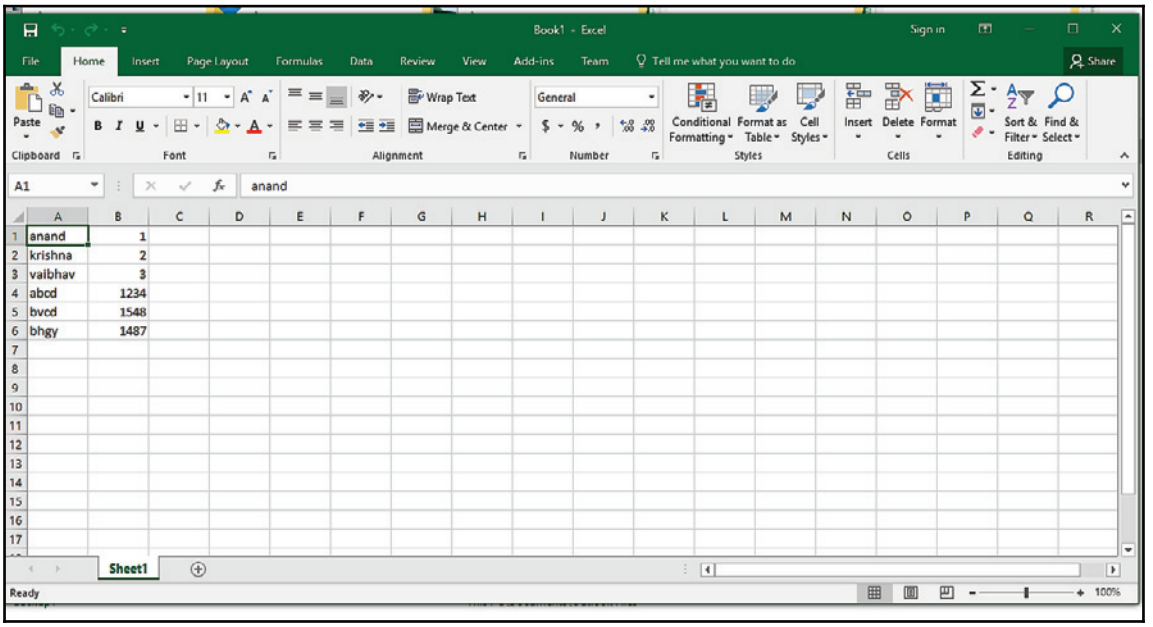
2. Drag and drop the **Read Range** activity inside the **Excel application scope** activity. The **Read Range** activity produces a data table. We have to receive this data table in order to consume it. Create a data table variable and specify it in the **Output** property of the **Read Range** activity:



3. Drag and drop the **Append Range** activity inside the **Excel application scope** activity. Specify the Excel file path in the **Append Range** activity (in which we want to append the data). Also, specify the data table (which is generated by the **Read Range** activity):



That's it. Press *F5* to see the result:



We can clearly see that the data has been appended successfully to the Excel sheet.

CSV/Excel to data table and vice versa (with a step-by-step example)

In this section, we will see how to extract data from an Excel file into a data table and vice versa. We will achieve this by:

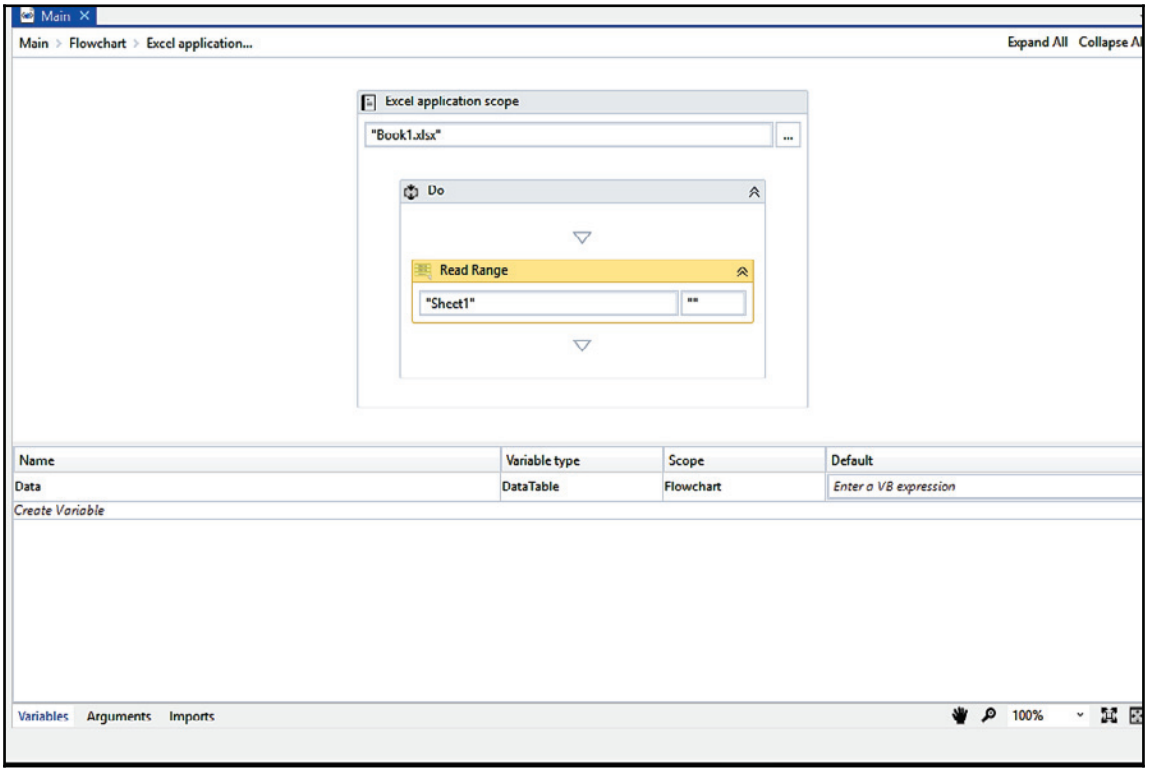
- Reading an Excel file and creating a data table using data from the Excel file
- Creating a data table and then writing all its data to an Excel file

Reading an Excel file and creating a data table by using data from the Excel file

We have an existing Excel file and we are going to use it in our project:

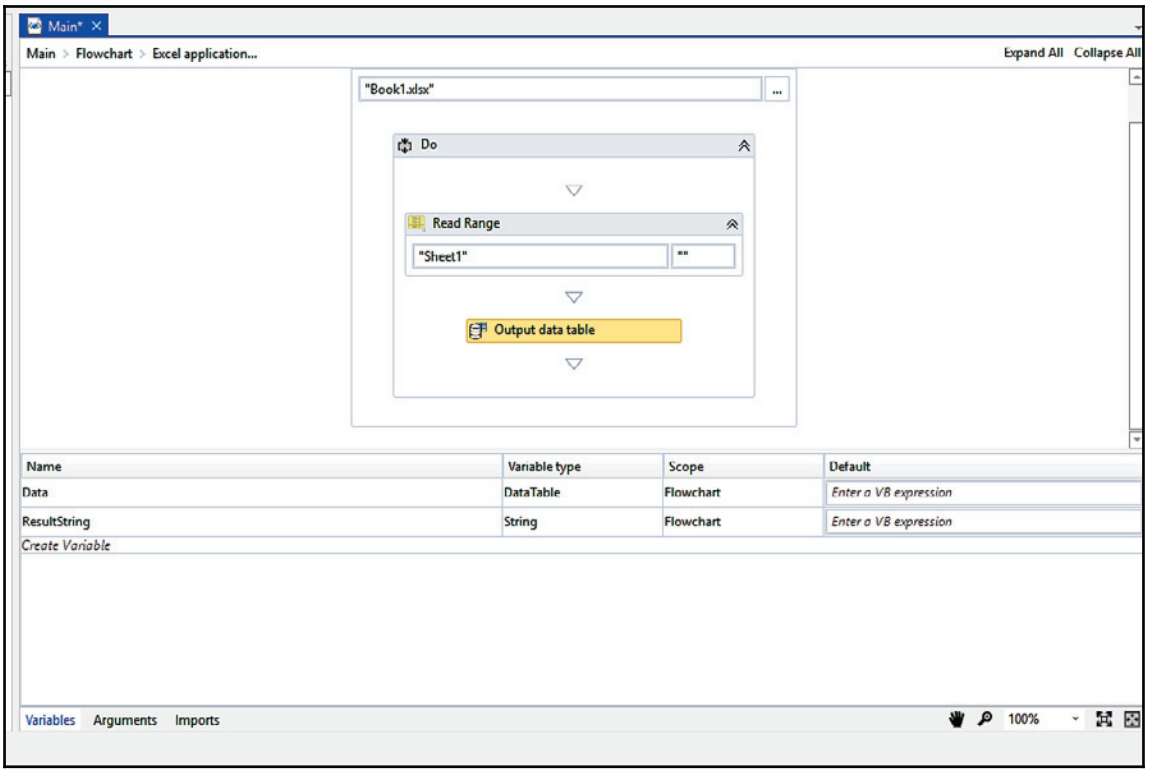
1. Drag and drop the **Flowchart** activity on the main Designer window. Also, drag and drop the **Excel application scope** inside the **Flowchart**.
2. Double-click on the **Excel application scope**. You have to specify the path of your workbook/Excel file. Drag and drop the **Read Range** activity from the **Activities** panel inside the **Excel application scope**.

   The **Read Range** activity will read the entire Excel sheet. We also have the option of specifying our range. Create a variable of type data table and specify it in the **Output** property of the **Read Range** activity. This variable will receive the data table produced by the **Read Range** activity:



3. Drag and drop the **Output Data Table** activity inside the **Excel application scope** activity. Now, we have to specify two properties of the **Output Data Table** activity: the **Data Table** property and the text property. The **Data Table** property of the **Output Data Table** activity is used to convert the **Data Table** into string format.

   The text property is used to supply its value in a string format. We have to receive this value in order to consume it. For this, let us create a variable of type string. Give it a meaningful name:



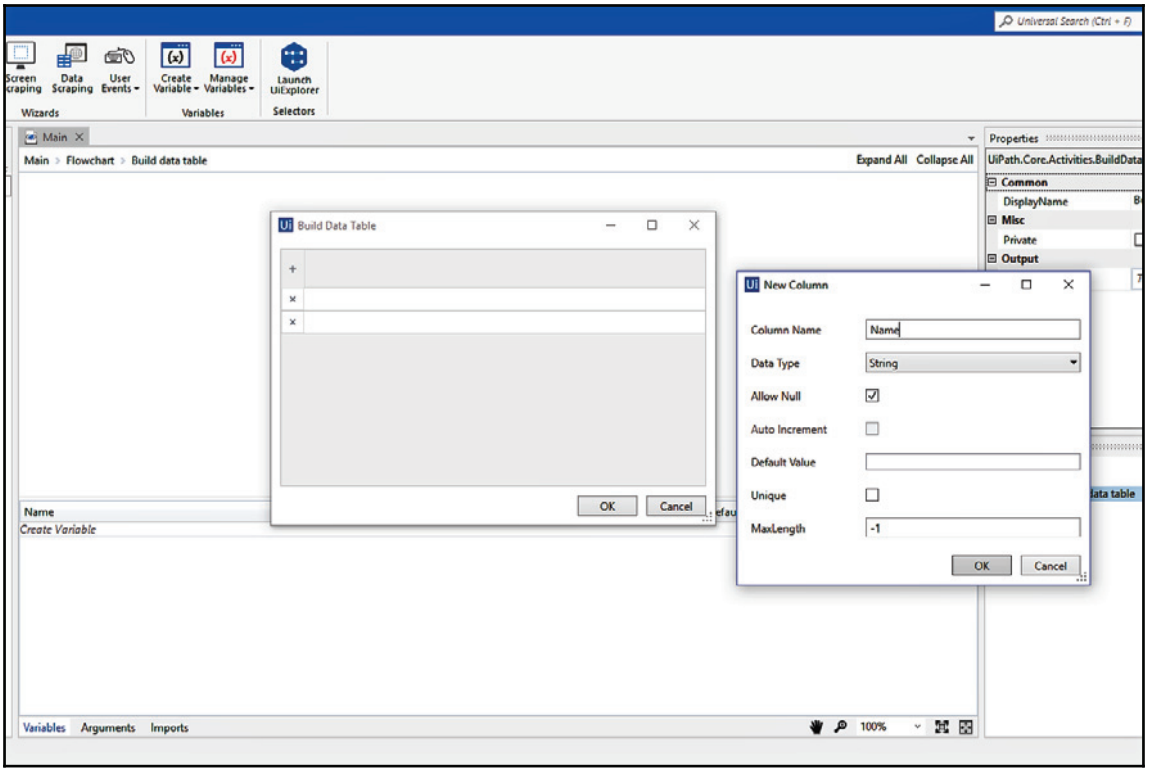
4. Drag and drop a **Message box** activity inside the **Excel application scope** activity. Also, specify the string variable's name that we created earlier inside the **Message box** activity.

That's it. Press *F5* to see the result. A window displaying the Excel file data will pop up.

Creating a data table and then writing all its data to an Excel file

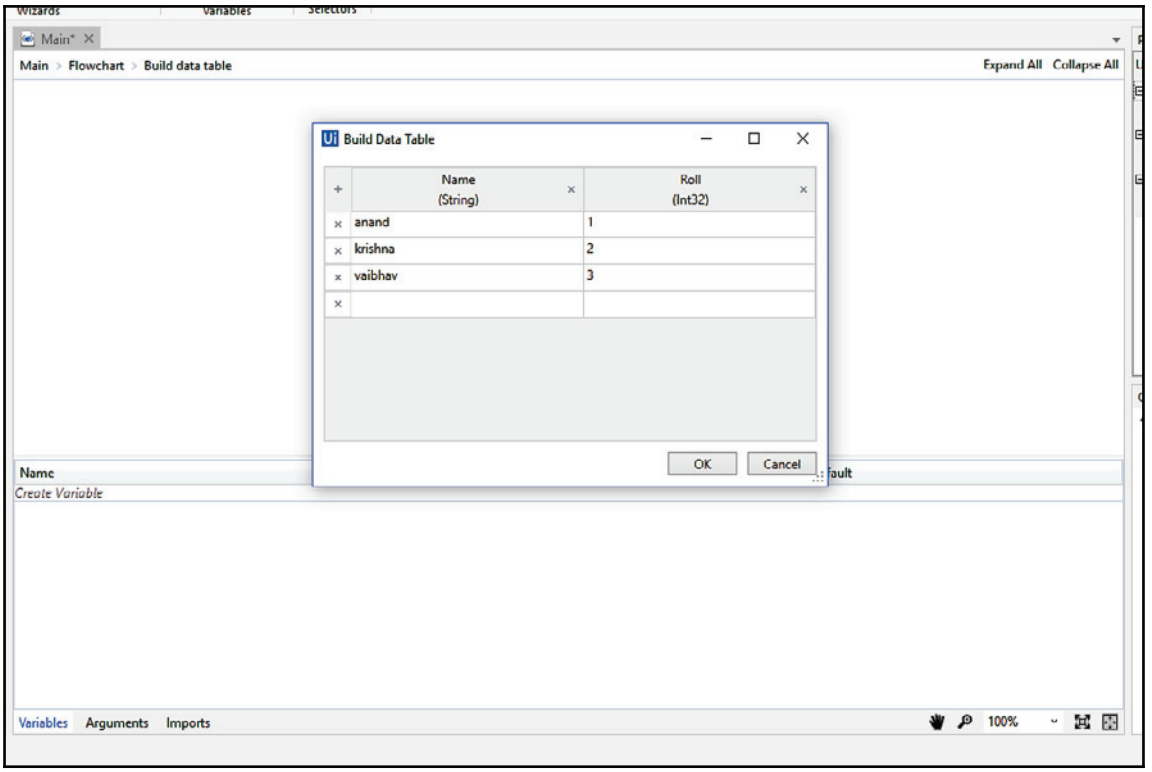
In this project, we will build a data table dynamically and then write all its data to an Excel file:

1. Drag and drop a **Build data table** activity from the **Activities** panel. Double-click on this activity. A window will pop up. Two columns have been generated automatically; delete these two columns. Add your column by clicking on the + icon and specify the column name. You can also select your preferred data type. You are free to add any number of columns:



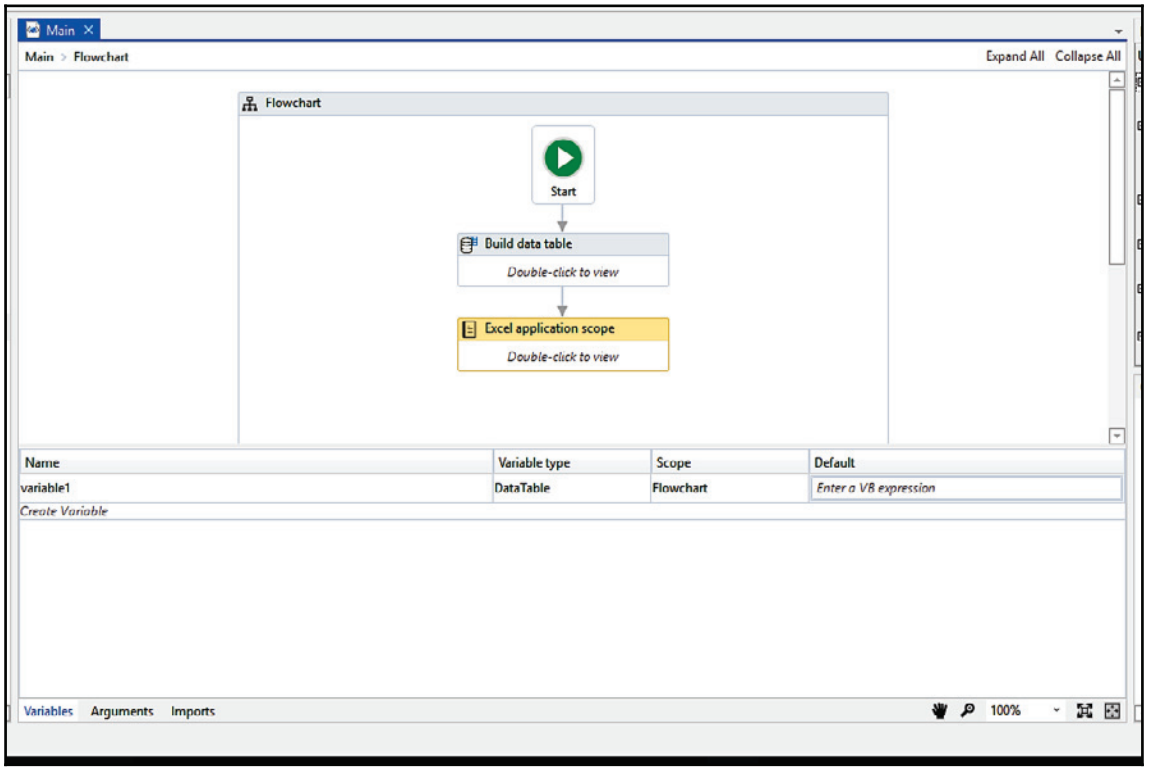
2. In this project, we are adding two columns. The procedure for adding the second column is almost the same. You just have to specify a name and its preferred data type. We have added one more column (Roll) and set the data type to **Int32** in the data table. We have also initialized this data table by giving some values to its rows.

   Create a variable of type **Data Table**. Give it a meaningful name. Specify this data table's name in the **Data Table** property of the **Build data table** activity. We have to supply this variable in order to get the data table that we have built:

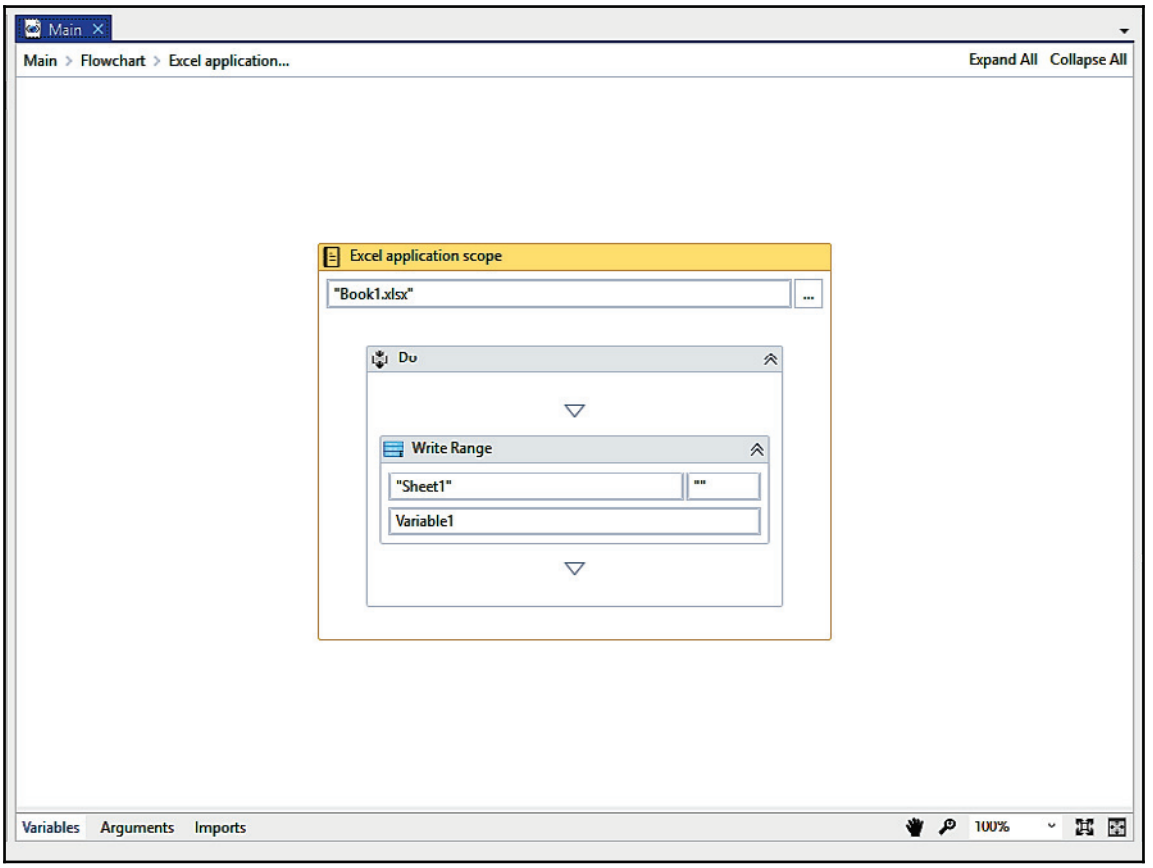


Our data table has been built successfully.

3. Drag and drop the **Excel application scope** inside the main Designer window. Specify the Excel sheet's path or manually select it. Connect this activity to the **Build Data table** activity:



4. Inside the **Excel application scope** activity, drag and drop the **Write Range** activity. Specify the data table variable name that we created earlier and set it as a **Data table** property inside the **Write Range** activity. We can also specify the range. In this case, we have assigned it as an empty string:



5. That's it. Hit the **Run** button or press *F5* to see the result.

Summary

In this chapter, you have learned techniques for using memory with variables. You also have learned about data tables and easy ways to manipulate data in memory.

Apart from using a variable or collection to store data, we have learned to store and manipulate data in a more persistent way using such files as CSV and Excel.

In the next chapter, we will learn to handle controls within applications in a better way.