



Data Analysis with Excel



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About the Tutorial

Data Analysis with Excel is a comprehensive tutorial that provides a good insight into the latest and advanced features available in Microsoft Excel. It explains in detail how to perform various data analysis functions using the features available in MS-Excel.

The tutorial has plenty of screenshots that explain how to use a particular feature, in a step-by-step manner.

Audience

This tutorial has been designed for all those readers who depend heavily on MS-Excel to prepare charts, tables, and professional reports that involve complex data. It will help all those readers who use MS-Excel regularly to analyze data.

Prerequisites

The readers of this tutorial are expected to have a good prior understanding of the basic features available in Microsoft Excel.

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Data Analysis with Excel

1. DATA ANALYSIS – OVERVIEW

Data Analysis is a process of inspecting, cleaning, transforming and modeling data with the goal of discovering useful information, suggesting conclusions and supporting decision-making.

Types of Data Analysis

Several data analysis techniques exist encompassing various domains such as business, science, social science, etc. with a variety of names. The major data analysis approaches are-

- Data Mining
- Business Intelligence
- Statistical Analysis
- Predictive Analytics
- Text Analytics

Data Mining

Data Mining is the analysis of large quantities of data to extract previously unknown, interesting patterns of data, unusual data and the dependencies. Note that the goal is the extraction of patterns and knowledge from large amounts of data and not the extraction of data itself.

Data mining analysis involves computer science methods at the intersection of the artificial intelligence, machine learning, statistics, and database systems.

The patterns obtained from data mining can be considered as a summary of the input data that can be used in further analysis or to obtain more accurate prediction results by a decision support system.

Business Intelligence

Business Intelligence techniques and tools are for acquisition and transformation of large amounts of unstructured business data to help identify, develop and create new strategic business opportunities.

The goal of business intelligence is to allow easy interpretation of large volumes of data to identify new opportunities. It helps in implementing an effective strategy based on insights that can provide businesses with a competitive market-advantage and long-term stability.

Statistical Analysis

Statistics is the study of collection, analysis, interpretation, presentation, and organization of data.

In data analysis, two main statistical methodologies are used-

- **Descriptive statistics:** In descriptive statistics, data from the entire population or a sample is summarized with numerical descriptors such as-
 - Mean, Standard Deviation for Continuous Data
 - Frequency, Percentage for Categorical Data
- **Inferential statistics:** It uses patterns in the sample data to draw inferences about the represented population or accounting for randomness. These inferences can be-
 - answering yes/no questions about the data (hypothesis testing)
 - estimating numerical characteristics of the data (estimation)
 - describing associations within the data (correlation)
 - modeling relationships within the data (E.g. regression analysis)

Predictive Analytics

Predictive Analytics use statistical models to analyze current and historical data for forecasting (predictions) about future or otherwise unknown events. In business, predictive analytics is used to identify risks and opportunities that aid in decision-making.

Text Analytics

Text Analytics, also referred to as Text Mining or as Text Data Mining is the process of deriving high-quality information from text. Text mining usually involves the process of structuring the input text, deriving patterns within the structured data using means such as statistical pattern learning, and finally evaluation and interpretation of the output.

Data Analysis Process

Data Analysis is defined by the statistician John Tukey in 1961 as "Procedures for analyzing data, techniques for interpreting the results of such procedures, ways of planning the gathering of data to make its analysis easier, more precise or more accurate, and all the machinery and results of (mathematical) statistics which apply to analyzing data."

Thus, data analysis is a process for obtaining large, unstructured data from various sources and converting it into information that is useful for-

- Answering questions

- Test hypotheses
- Decision-making
- Disproving theories

Data Analysis with Excel

Microsoft Excel provides several means and ways to analyze and interpret data. The data can be from various sources. The data can be converted and formatted in several ways. It can be analyzed with the relevant Excel commands, functions and tools - encompassing Conditional Formatting, Ranges, Tables, Text functions, Date functions, Time functions, Financial functions, Subtotals, Quick Analysis, Formula Auditing, Inquire Tool, What-if Analysis, Solvers, Data Model, PowerPivot, PowerView, PowerMap, etc.

You will be learning these data analysis techniques with Excel as part of two parts-

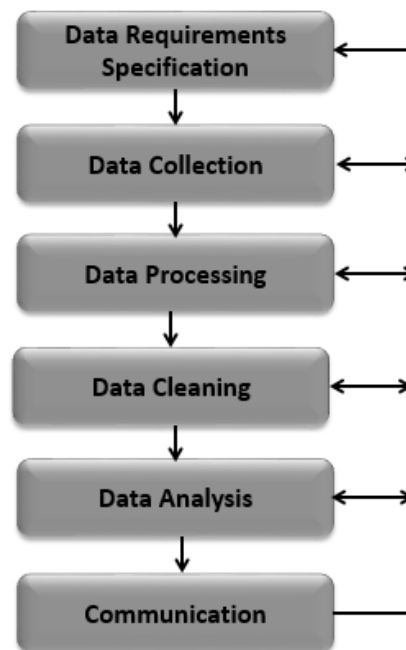
- Data Analysis with Excel and
- Advanced Data Analysis with Excel

2. DATA ANALYSIS PROCESS

Data Analysis is a process of collecting, transforming, cleaning, and modeling data with the goal of discovering the required information. The results so obtained are communicated, suggesting conclusions, and supporting decision-making. Data visualization is at times used to portray the data for the ease of discovering the useful patterns in the data. The terms Data Modeling and Data Analysis mean the same.

Data Analysis Process consists of the following phases that are iterative in nature-

- Data Requirements Specification
- Data Collection
- Data Processing
- Data Cleaning
- Data Analysis
- Communication



Data Requirements Specification

The data required for analysis is based on a question or an experiment. Based on the requirements of those directing the analysis, the data necessary as inputs to the analysis is identified (e.g., Population of people). Specific variables regarding a population (e.g., Age and Income) may be specified and obtained. Data may be numerical or categorical.

Data Collection

Data Collection is the process of gathering information on targeted variables identified as data requirements. The emphasis is on ensuring accurate and honest collection of data. Data Collection ensures that data gathered is accurate such that the related decisions are valid. Data Collection provides both a baseline to measure and a target to improve.

Data is collected from various sources ranging from organizational databases to the information in web pages. The data thus obtained, may not be structured and may contain irrelevant information. Hence, the collected data is required to be subjected to Data Processing and Data Cleaning.

Data Processing

The data that is collected must be processed or organized for analysis. This includes structuring the data as required for the relevant Analysis Tools. For example, the data might have to be placed into rows and columns in a table within a Spreadsheet or Statistical Application. A Data Model might have to be created.

Data Cleaning

The processed and organized data may be incomplete, contain duplicates, or contain errors. Data Cleaning is the process of preventing and correcting these errors. There are several types of Data Cleaning that depend on the type of data. For example, while cleaning the financial data, certain totals might be compared against reliable published numbers or defined thresholds. Likewise, quantitative data methods can be used for outlier detection that would be subsequently excluded in analysis.

Data Analysis

Data that is processed, organized and cleaned would be ready for the analysis. Various data analysis techniques are available to understand, interpret, and derive conclusions based on the requirements. Data Visualization may also be used to examine the data in graphical format, to obtain additional insight regarding the messages within the data.

Statistical Data Models such as Correlation, Regression Analysis can be used to identify the relations among the data variables. These models that are descriptive of the data are helpful in simplifying analysis and communicate results.

The process might require additional Data Cleaning or additional Data Collection, and hence these activities are iterative in nature.

Communication

The results of the data analysis are to be reported in a format as required by the users to support their decisions and further action. The feedback from the users might result in additional analysis.

The data analysts can choose data visualization techniques, such as tables and charts, which help in communicating the message clearly and efficiently to the users. The analysis tools provide facility to highlight the required information with color codes and formatting in tables and charts.

3. DATA ANALYSIS WITH EXCEL – OVERVIEW

Excel provide commands, functions and tools that make your data analysis tasks easy. You can avoid many time consuming and/or complex calculations using Excel. In this tutorial, you will get a head start on how you can perform data analysis with Excel. You will understand with relevant examples, step by step usage of Excel commands and screen shots at every step.

Ranges and Tables

The data that you have can be in a range or in a table. Certain operations on data can be performed whether the data is in a range or in a table.

However, there are certain operations that are more effective when data is in tables rather than in ranges. There are also operations that are exclusively for tables.

You will understand the ways of analyzing data in ranges and tables as well. You will understand how to name ranges, use the names and manage the names. The same would apply for names in the tables.

Data Cleaning – Text Functions, Dates and Times

You need to clean the data obtained from various sources and structure it before proceeding to data analysis. You will learn how you can clean the data

- With Text Functions
- Containing Date Values
- Containing Time Values

Conditional Formatting

Excel provides you conditional formatting commands that allow you to color the cells or font, have symbols next to values in the cells based on predefined criteria. This helps one in visualizing the prominent values. You will understand the various commands for conditionally formatting the cells.

Sorting and Filtering

During the preparation of data analysis and/or to display certain important data, you might have to sort and/or filter your data. You can do the same with the easy to use sorting and filtering options that you have in Excel.

Subtotals with Ranges

As you are aware, PivotTable is normally used to summarize data. However, Subtotals with Ranges is another feature provided by Excel that will allow you to group / ungroup data and summarize the data present in ranges with easy steps.

Quick Analysis

With Quick Analysis tool in Excel, you can quickly perform various data analysis tasks and make quick visualizations of the results.

Understanding Lookup Functions

Excel Lookup Functions enable you to find the data values that match a defined criteria from a huge amount of data.

PivotTables

With PivotTables you can summarize the data, prepare reports dynamically by changing the contents of the PivotTable.

Data Visualization

You will learn several Data Visualization techniques using Excel Charts. You will also learn how to create Band Chart, Thermometer Chart, Gantt chart, Waterfall Chart, Sparklines and PivotCharts.

Data Validation

It might be required that only valid values be entered into certain cells. Otherwise, they may lead to incorrect calculations. With data validation commands, you can easily set up data validation values for a cell, an input message prompting the user on what is expected to be entered in the cell, validate the values entered with the defined criteria and display an error message in case of incorrect entries.

Financial Analysis

Excel provides you several financial functions. However, for commonly occurring problems that require financial analysis, you can learn how to use a combination of these functions.

Working with Multiple Worksheets

You might have to perform several identical calculations in more than one worksheet. Instead of repeating these calculations in each worksheet, you can do it one worksheet and have it appear in the other selected worksheets as well. You can also summarize the data from the various worksheets into a report worksheet.

Formula Auditing

When you use formulas, you might want to check whether the formulas are working as expected. In Excel, Formula Auditing commands help you in tracing the precedent and dependent values and error checking.

Inquire

Excel also provides Inquire add-in that enables you compare two workbooks to identify changes, create interactive reports, and view the relationships among workbooks, worksheets, and cells. You can also clean the excessive formatting in a worksheet that makes Excel slow or makes the file size huge.

4. WORKING WITH RANGE NAMES

While doing Data Analysis, referring to various data will be more meaningful and easy if the reference is by Names rather than cell references – either a single cell or a range of cells. For example, if you are calculating Net Present Value based on a Discount Rate and a series of Cash Flows, the formula

$$\text{Net_Present_Value} = \text{NPV}(\text{Discount_Rate}, \text{Cash_Flows})$$

is more meaningful than

$$C10 = \text{NPV}(C2, C6:C8)$$

With Excel, you can create and use meaningful names to various parts of your data. The advantages of using range names include-

- A meaningful Range name (such as Cash_Flows) is much easier to remember than a Range address (such as C6:C8).
- Entering a name is less error prone than entering a cell or range address.
- If you type a name incorrectly in a formula, Excel will display a **#NAME?** error.
- You can quickly move to areas of your worksheet by using the defined names.
- With Names, your formulas will be more understandable and easier to use. For example, a formula `Net_Income = Gross_Income – Deductions` is more intuitive than `C40 = C20 – B18`.
- Creating formulas with range names is easier than with cell or range addresses. You can copy a cell or range name into a formula by using formula Autocomplete.

In this chapter, you will learn-

- Syntax rules for names.
- Creating names for cell references.
- Creating names for constants.
- Managing the names.
- Scope of your defined names.
- Editing names.
- Filtering names.

- Deleting names.
- Applying names.
- Using names in a formula.
- Viewing names in a workbook.
- Using paste names and paste list.
- Using names for range intersections.
- Copying formulas with names.

Copying Name using Formula Autocomplete

Type the first letter of the name in the formula. A drop-down box appears with function names and range names. Select the required name. It is copied into your formula.

The screenshot shows an Excel worksheet with the following data:

Year	Cash flow
0	(600)
1	200
2	200
3	500

The formula bar shows the formula `=NPV(Interest_Rate,c)`. The dropdown menu for the formula bar is open, showing a list of functions and range names. The function `Cash_Flows` is selected.

The dropdown menu contains the following items:

- Cash_Flows
- CEILING.MATH
- CELL
- CHAR
- CHISQ.DIST
- CHISQ.DIST.RT
- CHISQ.INV
- CHISQ.INV.RT
- CHISQ.TEST
- CHOOSE
- CLEAN
- CODE

Range Name Syntax Rules

Excel has the following syntax rules for names-

- You can use any combination of letters, numbers and the symbols - underscores, backslashes, and periods. Other symbols are not allowed.
- A name can begin with a character, underscore or backslash.
- A name cannot begin with a number (example- 1stQuarter) or resemble a cell address (example- QTR1).
- If you prefer to use such names, precede the name with an underscore or a backslash (example- \1stQuarter, _QTR1)
- Names cannot contain spaces. If you want to distinguish two words in a name, you can use underscore (example- Cash_Flows instead of Cash Flows)
- Your defined names should not clash with Excel's internally defined names, such as **Print_Area**, **Print_Titles**, **Consolidate_Area**, and **Sheet_Title**. If you define the same names, they will override the Excel's internal names and you will not get any error message. However, it is advised not to do so.
- Keep the names short but understandable, though you can use up to 255 characters

Creating Range Names

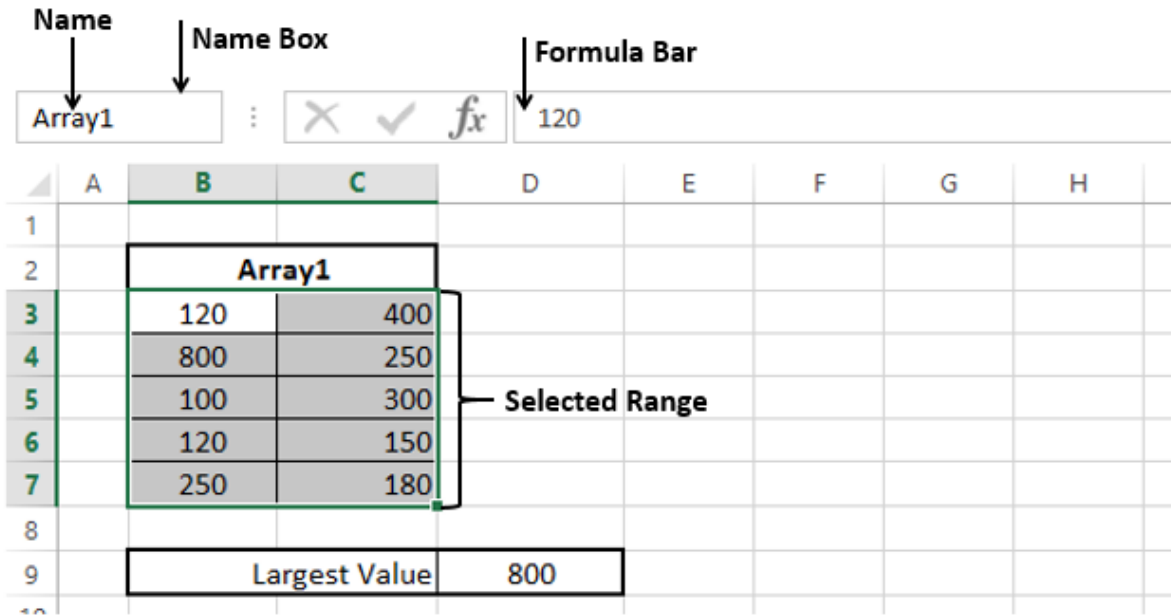
You can create Range Names in two ways-

- Using the **Name box**.
- Using the **New Name** dialog box.
- Using the **Selection** dialog box.

Create a Range Name using the Name Box

To create a Range name, using the **Name** box that is to the left of formula bar is the fastest way. Follow the steps given below-

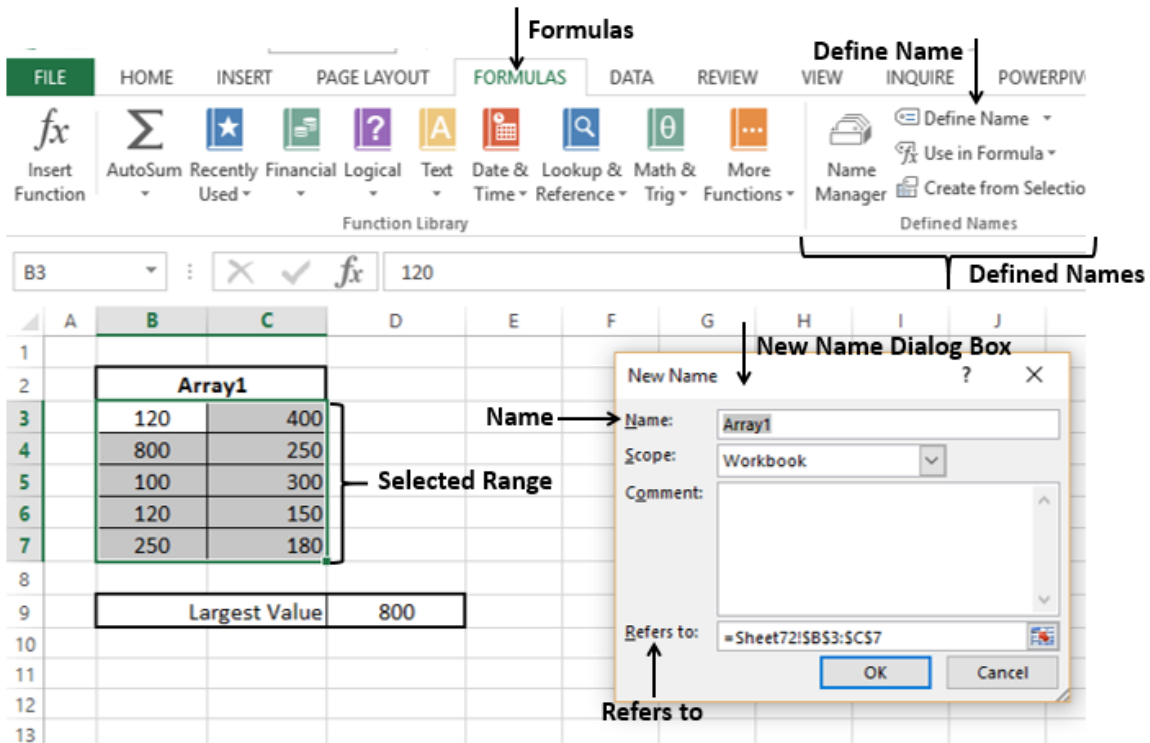
1. Select the range for which you want to define a Name.
2. Click on the Name box.
3. Type the name and press Enter to create the Name.



Create a Range Name using the New Name dialog box

You can also create Range Names using the New Name dialog box from Formulas tab.

1. Select the range for which you want to define a name.
2. Click the Formulas tab.
3. Click Define Name in the Defined Names group. The **New Name** dialog box appears.
4. Type the name in the box next to Name
5. Check that the range that is selected and displayed in the Refers to box is correct. Click OK.



Create a Range Name using the Create Names from Selection dialog box

You can also create Range names using the **Create Names** from the Selection dialog box from Formulas tab, when you have Text values that are adjacent to your range.

1. Select the range for which you want to define a name along with the row / column that contains the name.
2. Click the Formulas tab.
3. Click **Create from Selection** in the Defined Names group. The **Create Names from Selection** dialog box appears.
4. Select top row as the Text appears in the top row of the selection
5. Check the range that got selected and displayed in the box next to Refers to be correct. Click OK.

Formulas

FILE HOME INSERT PAGE LAYOUT FORMULAS DATA REVIEW VIEW INQUIRE POWERPivot

fx Insert Function Σ AutoSum Recently Used Financial Logical Text Date & Time Lookup & Reference Math & Trig More Functions

Function Library

Create from Selection

Define Name Use in Formula Create from Selection

Defined Names

B2 X ✓ fx Array1

Selected Range

Create Names from Selection^K Dialog Box

Create names from values in the:

☒ Top row

☐ Left column

☐ Bottom row

☐ Right column

OK Cancel

	A	B	C	D	E	F	G
1							
2		Array1					
3		120	400				
4		800	250				
5		100	300				
6		120	150				
7		250	180				
8							
9		Largest Value		800			
10							

Now, you can find the largest value in the range with **=Sum** (Student Name), as shown below-

Range Name in Formula

	A	B	C	D
1				
2		Array1		
3		120	400	
4		800	250	
5		100	300	
6		120	150	
7		250	180	
8				
9		Largest Value	=LARGE(Array1,1)	

You can create names with multiple selection also. In the example given below, you can name the row of marks of each student with the student's name.

The screenshot shows the Excel interface with the **Formulas** tab selected. The **Create from Selection** group is highlighted, and the **Create Names from Selection** dialog box is open. The dialog box shows the following options:

- ☐ Top row
- ☒ Left column
- ☐ Bottom row
- ☐ Right column

The **Left column** option is selected, indicating that the student names in the first column of the selected range will be used to name the rows of exam scores.

Now, you can find the total marks for each student with **=Sum** (student name), as shown below.

	A	B	C	D	E	F	G
1		First Quarter Exam Scores					
2							
3		Student	Exam 1	Exam 2	Exam 3	Exam 4	Total
4		Kreiger, Doris	87	90	79	96	=SUM(Kreiger_Doris)
5		Oliviera, Manuel	92	94	85	97	=SUM(Oliviera_Manuel)
6		Kodeda, Adam	88	95	75	80	=SUM(Kodeda_Adam)
7		Lange, Michael	85	87	87	88	=SUM(Lange_Michael)
8		Taylor, Maurice	81	88	82	85	=SUM(Taylor_Maurice)

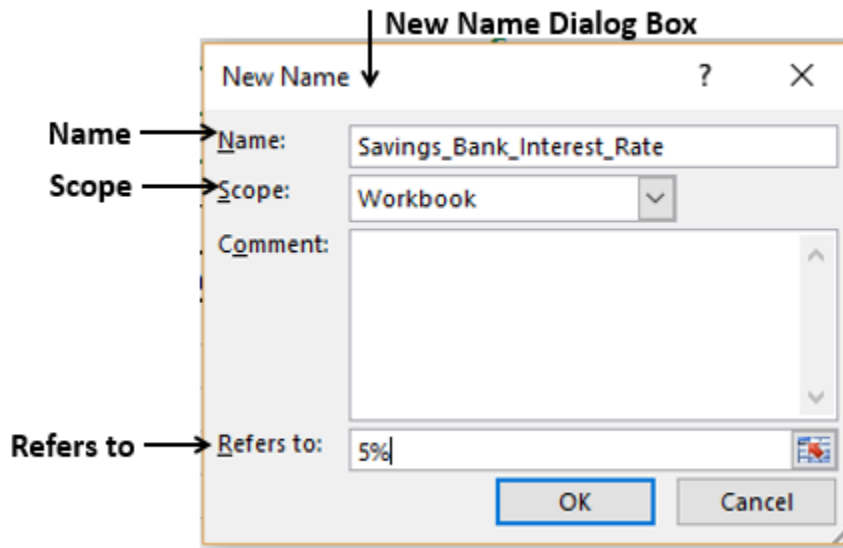
The table shows the exam scores for five students. The **Total** column uses the **=SUM** function with the student name as the range name to calculate the total marks for each student.

Creating Names for Constants

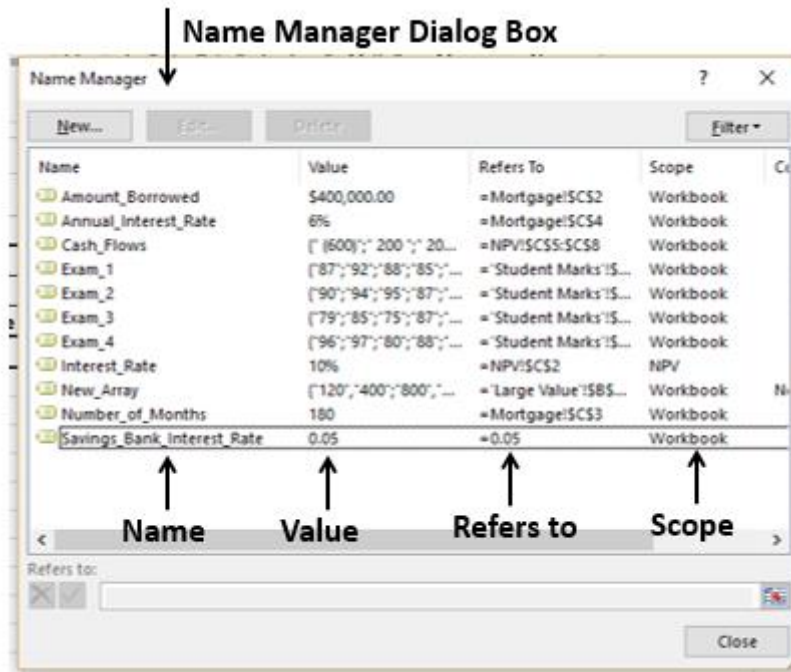
Suppose you have a constant that will be used throughout your workbook. You can assign a name to it directly, without placing it in a cell.

In the example below, Savings Bank Interest Rate is set to 5%.

- Click Define Name.
- In the New Name dialog box, type Savings_Bank_Interest_Rate in the Name box.
- In Scope, select Workbook.
- In Refers to box, clear the contents and type 5%.
- Click OK.



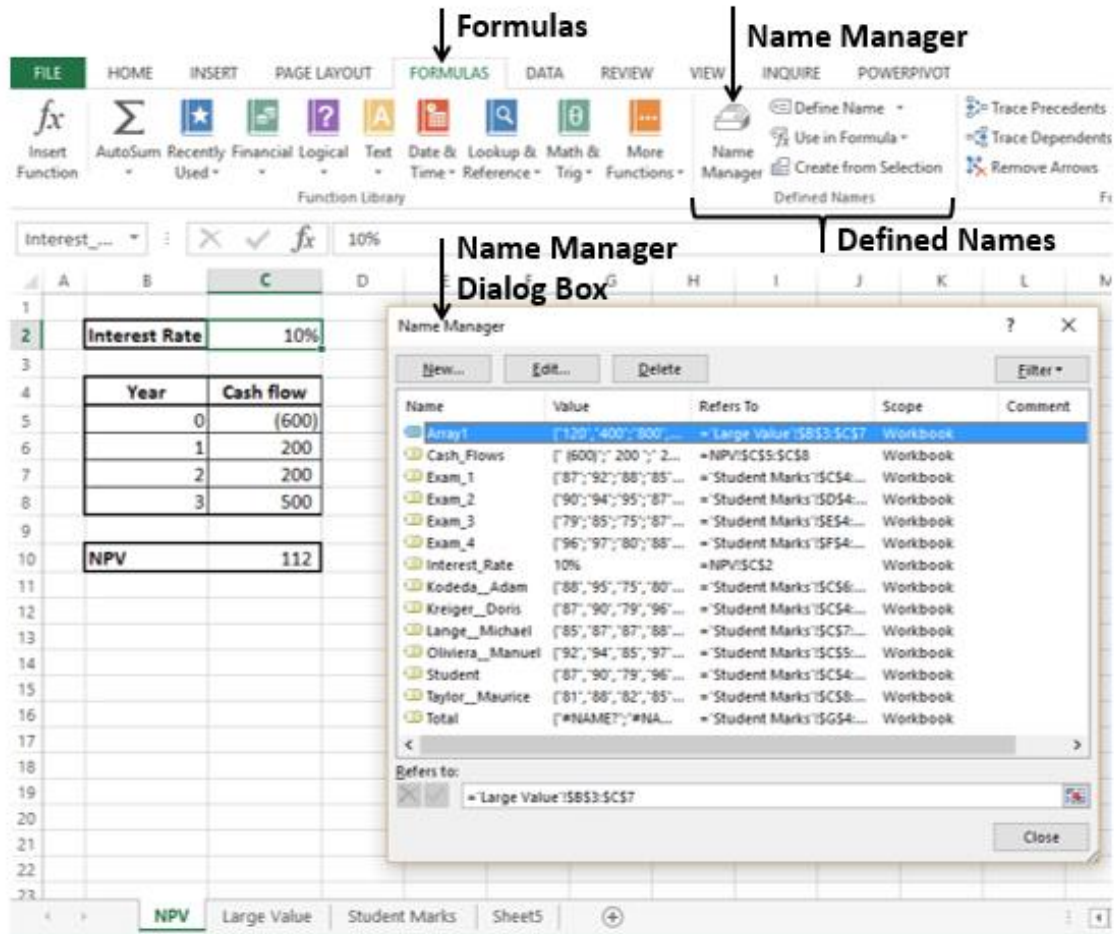
The Name **Savings_Bank_Interest_Rate** is set to a constant 5%. You can verify this in Name Manager. You can see that the value is set to 0.05 and in the **Refers to** =0.05 is placed.



Managing Names

An Excel Workbook can have any number of named cells and ranges. You can manage these names with the Name Manager.

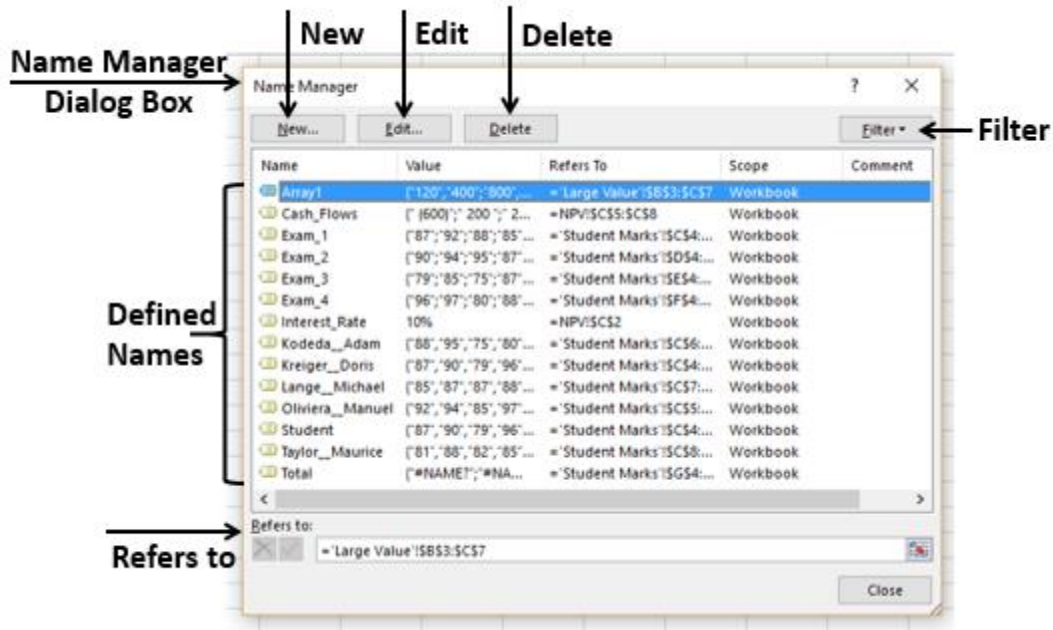
- Click the Formulas tab.
- Click **Name Manager** in the **Defined Names** group. The **Name Manager** dialog box appears. All the names defined in the current workbook are displayed.



The List of **Names** are displayed with the defined **Values**, **Cell Reference** (including Sheet Name), **Scope** and **Comment**.

The Name Manager has the options to-

- Define a **New** Name with the **New** Button.
- **Edit** a Defined Name.
- **Delete** a Defined Name.
- **Filter** the Defined Names by Category.
- Modify the Range of a Defined Name that it **Refers to**.



Scope of a Name

The **Scope** of a name by default is the workbook. You can find the **Scope** of a defined names from the list of names under the **Scope** column in the **Name Manager**.

You can define the **Scope** of a **New Name** when you define the name using **New Name** dialog box. For example, you are defining the name **Interest_Rate**. Then you can see that the **Scope** of the **New Name** **Interest_Rate** is the **Workbook**.

The screenshot illustrates the process of defining a name in Excel. The **Formulas** tab is selected, and the **Define Name** dropdown menu is open. The **New Name** dialog box is displayed, showing the following details:

- Name:** Interest_Rate
- Scope:** Workbook
- Refers to:** =NPV!\$C\$2

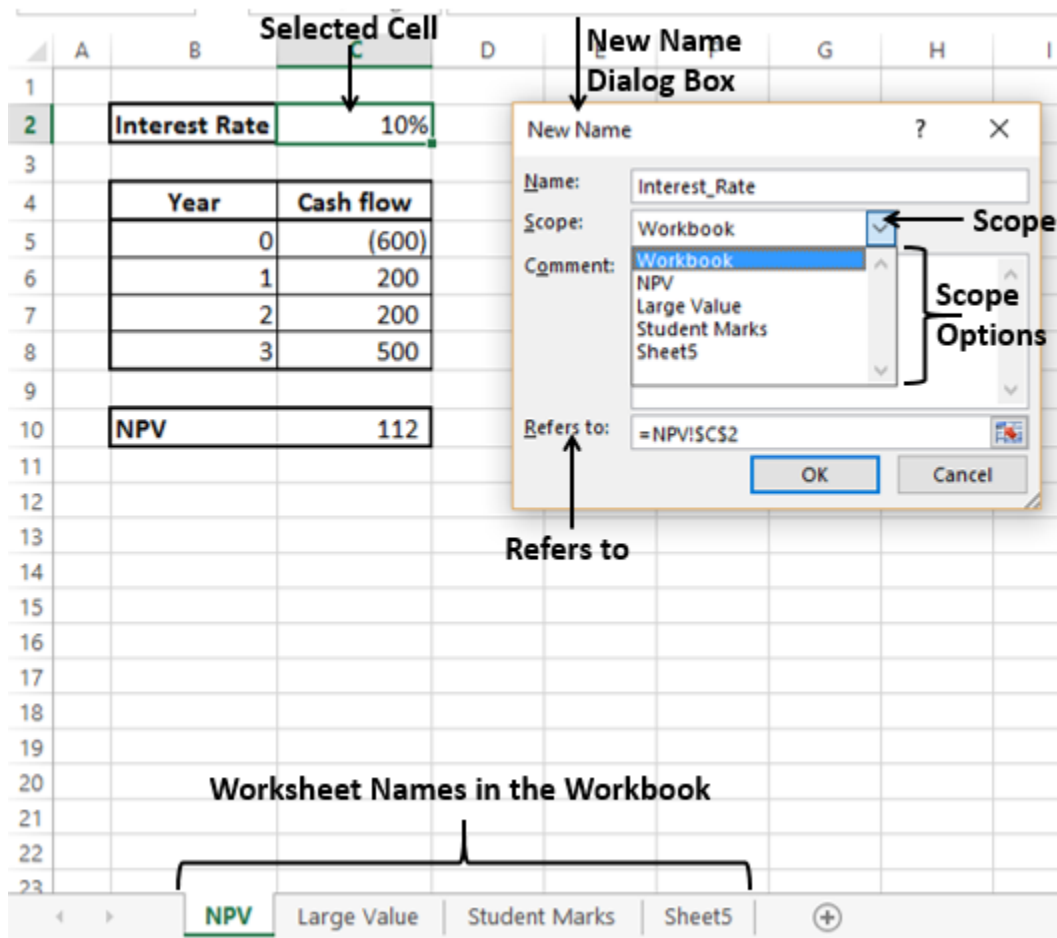
The spreadsheet shows a table with the following data:

Year	Cash flow
0	(600)
1	200
2	200
3	500

The **Interest Rate** is 10%, and the **NPV** is 112.

Suppose you want the **Scope** of this interest rate restricted to this **Worksheet** only.

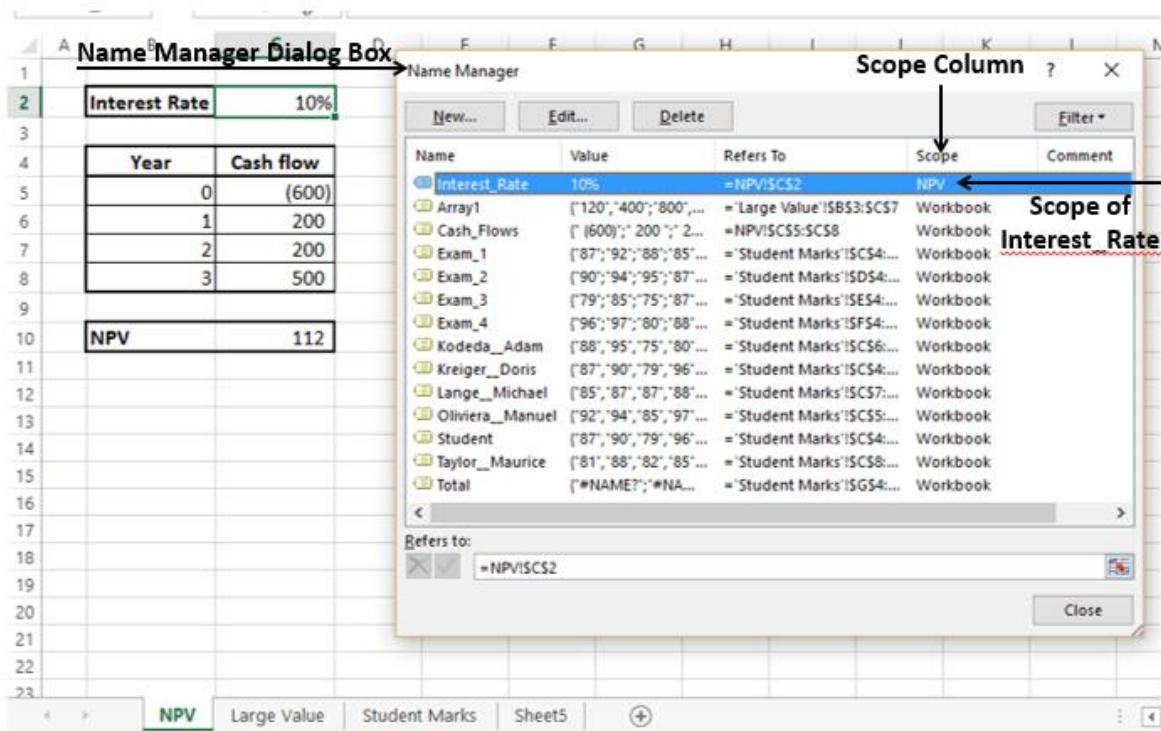
1. Click the down-arrow in the Scope Box. The available Scope options appear in the drop-down list.



The Scope options include **Workbook**, and the sheet names in the workbook.

2. Click the current worksheet name, in this case NPV and click OK. You can define / find the sheet name in the worksheet tab.

3. To verify that Scope is worksheet, click **Name Manager**. In the Scope column, you will find NPV for Interest_Rate. This means you can use the Name Interest_Rate only in the Worksheet NPV, but not in the other Worksheets.



Note: Once you define the Scope of a Name, it cannot be modified later.

Deleting Names with Error Values

Sometimes, it may so happen that Name definition may have errors for various reasons. You can delete such names as follows-

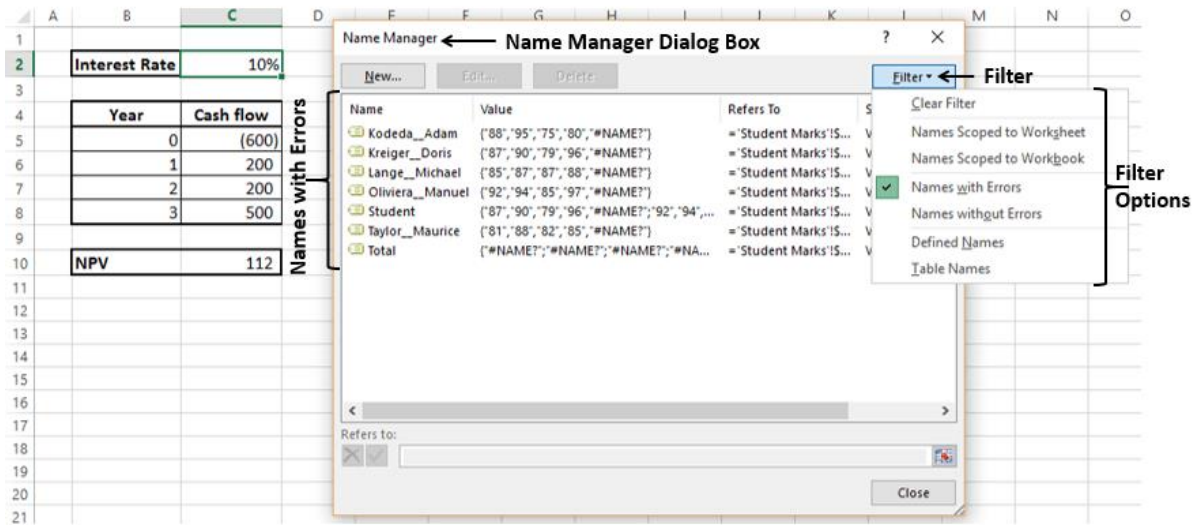
1. Click **Filter** in the **Name Manager** dialog box.

The following filtering options appear-

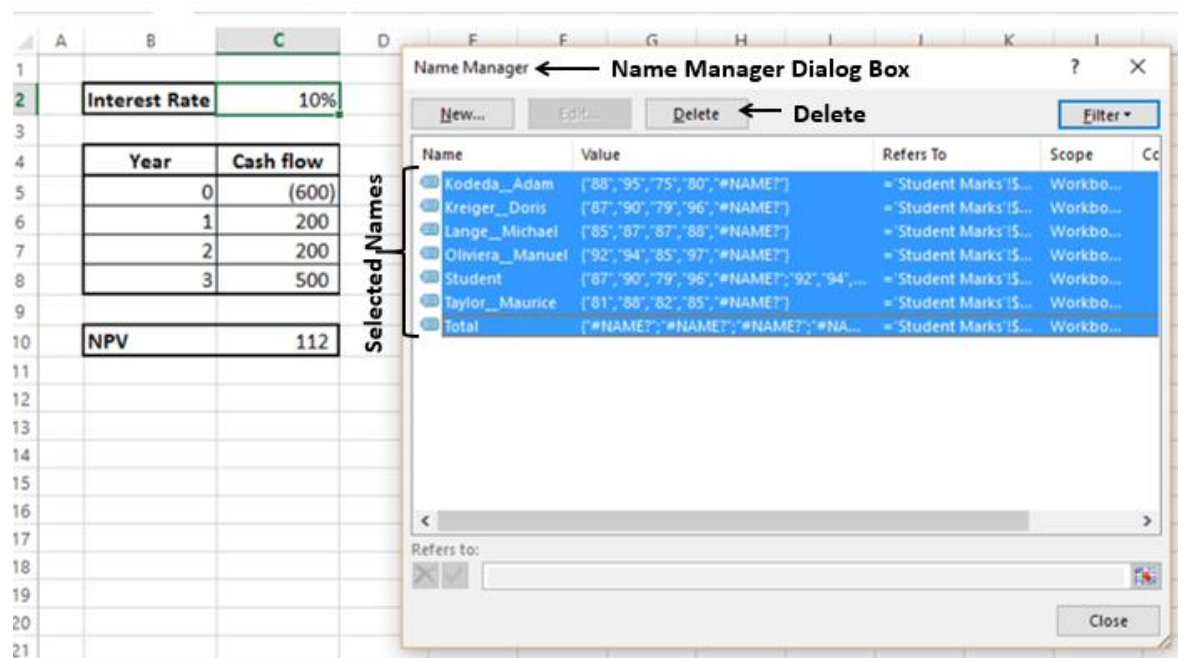
- Clear Filter
- Names Scoped to Worksheet
- Names Scoped to Workbook
- Names with Errors
- Names without Errors
- Defined Names
- Table Names

You can apply **Filter** to the **defined Names** by selecting one or more of these options.

2. Select **Names with Errors**. Names that contain error values will be displayed.



3. From the obtained list of **Names**, select the ones you want to delete and click **Delete**.



You will get a message, confirming delete. Click OK.

Editing Names

You can use the **Edit** option in the **Name Manager** dialog box to-

- Change the **Name**.

- Modify the **Refers to** range
- Edit the **Comment** in a **Name**.

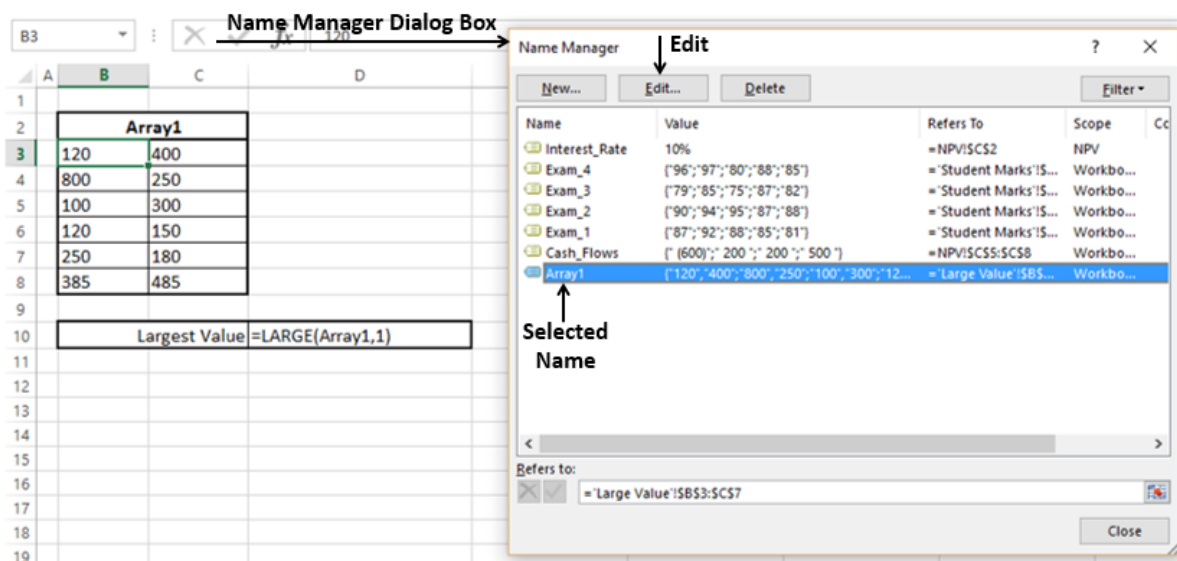
Change the Name

1. Click the cell containing the function **Large**.

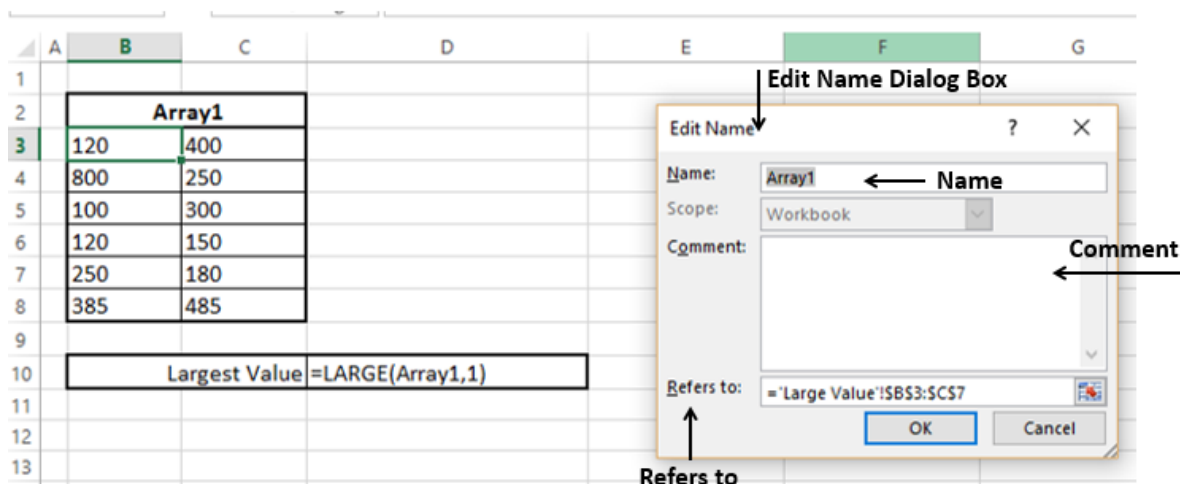
You can see, two more values are added in the array, but are not included in the function as they are not part of Array1.

2	Array1	
3	120	400
4	800	250
5	100	300
6	120	150
7	250	180
8	385	485
9		
10	Largest Value	=LARGE(Array1,1)

2. Click the **Name** you want to edit in the **Name Manager** dialog box. In this case, **Array1**.



3. Click **Edit**. The **Edit Name** dialog box appears.

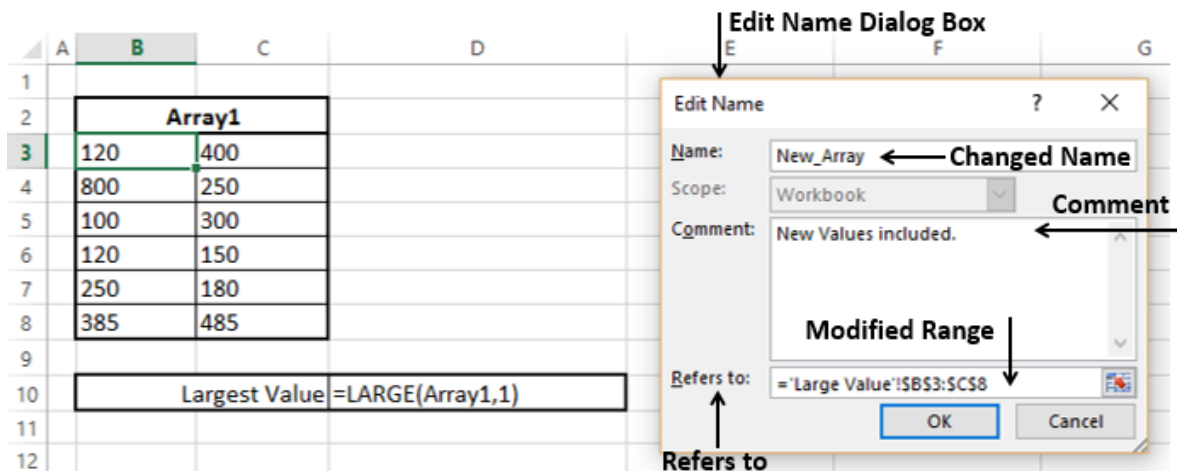


4. Change the **Name** by typing the new name that you want in the **Name Box**.

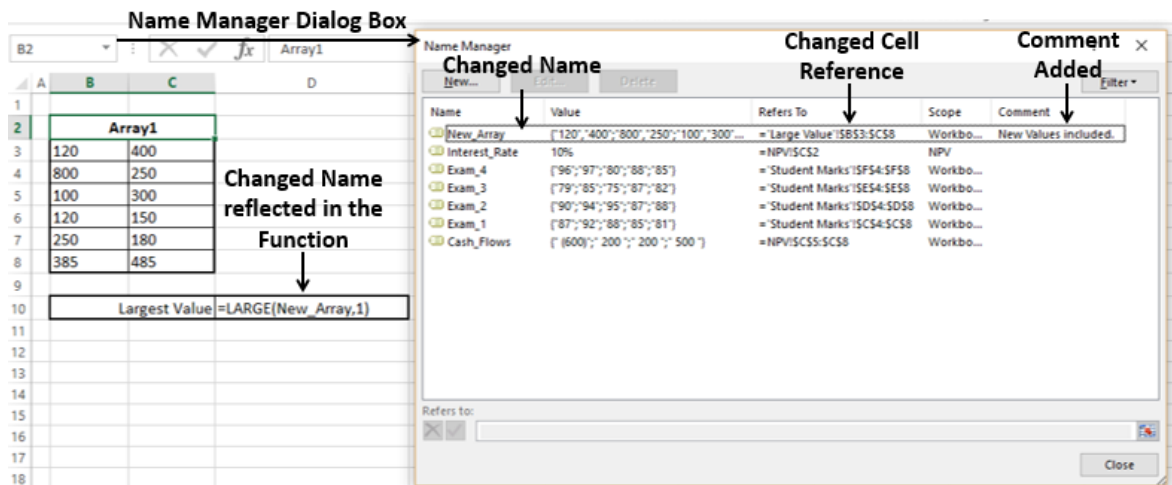
5. Click the **Range** button to the right of **Refers to** Box and include the new cell references.

6. Add a **Comment** (Optional)

Notice that **Scope** is deactive and hence cannot be changed.



Click OK. You will observe the changes made.



Applying Names


Consider the following example-

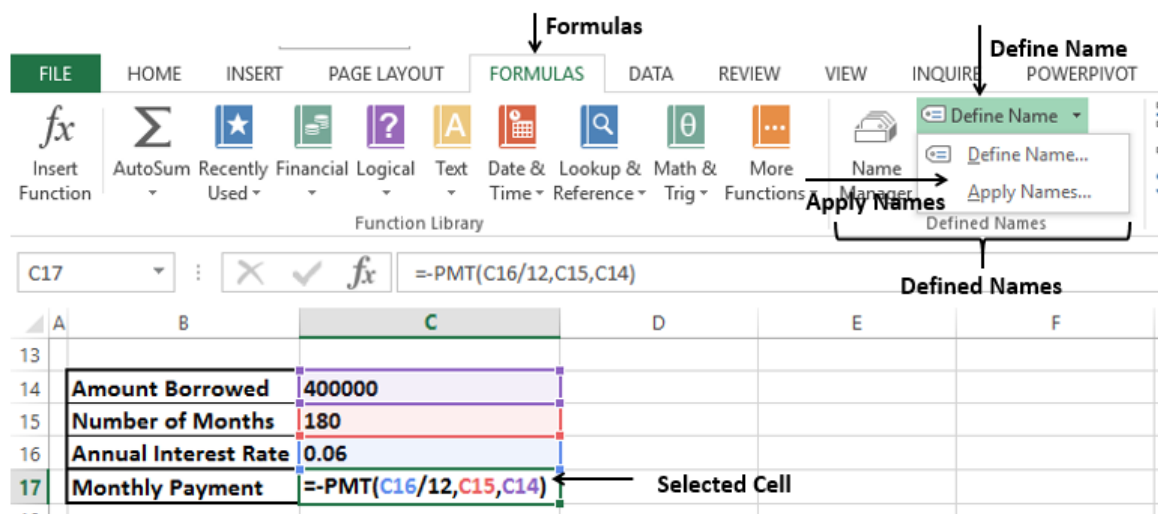
	A	B	C
13			
14		Amount Borrowed	400000
15		Number of Months	180
16		Annual Interest Rate	0.06
17		Monthly Payment	=PMT(C16/12,C15,C14)

As you observe, names are not defined and used in PMT function. If you place this function somewhere else in the worksheet, you also need to remember where exactly the parameter values are. You know that using names is a better option.

In this case, the function is already defined with cell references that do not have names. You can still define names and apply them.

1. Using **Create from Selection**, define the names.

2. Select the cell containing the formula. Click  next to **Define Name** in the **Defined Names** group on the **Formulas** tab. From the drop-down list, click **Apply Names**.



The screenshot shows the Excel ribbon with the **Formulas** tab selected. The **Defined Names** group is visible, and the **Define Name** dropdown menu is open, showing the **Apply Names** option. Below the ribbon, the worksheet is shown with cell C17 selected, containing the formula `=PMT(C16/12,C15,C14)`. The cells B14, B15, and B16 are highlighted in purple, red, and blue respectively, corresponding to the parameters in the formula.

3. The **Apply Names** dialog box appears. Select the **Names** that you want to **Apply** and click OK.

The screenshot shows the Excel interface with the 'FORMULAS' tab active. The 'Function Library' group is visible. The 'Apply Names' dialog box is open, displaying a list of names to be applied to the selected cells. The names listed are: Amount_Borrowed, Amt_Borrowed, Annual_int_rate, Annual_Interest_Rate, Cash_Flows, Exam_1, Exam_2, Exam_3, Exam_4, New_Array, and Number_of_Months. The 'Ignore Relative/Absolute' and 'Use row and column names' checkboxes are checked. The 'Options >>' button is visible.

The selected names will be applied to the selected cells.

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