By Archana Kumari

POJECT WRITE-UP:

PREDICTING RESTAURANT TIPS USING EXCEL.

Objectives:

The goal of this project is to predict the tips left by customers at a restaurant based on several influencing factors. By analyzing the provided dataset, we aim to identify the relationship between these factors and tips, build a predictive model, and evaluate its performance using statistical metrics. Microsoft Excel will be the primary tool for performing the tasks, leveraging its built-in functions, formulas, and the Data Analysis Add-in.

Dataset Description:

The dataset, *Restaurant Tips Dataset*, contains the following features:

1. **Independent Variables:**
    - sex: Gender of the customer (Male/Female).
    - smoker: Indicates whether the customer is a smoker (Yes/No).
    - day: The day of the week the customer visited (e.g., Thursday, Friday).
    - time: Indicates whether the meal was lunch or dinner.
    - size: Number of members in the dining party.
    - total bill: The total bill amount in USD.
2. **Dependent Variable:**
    - tip: The tip amount in USD provided by the customer.

PROJECT TASKS:

- **Download the data:** Provided by the organization.

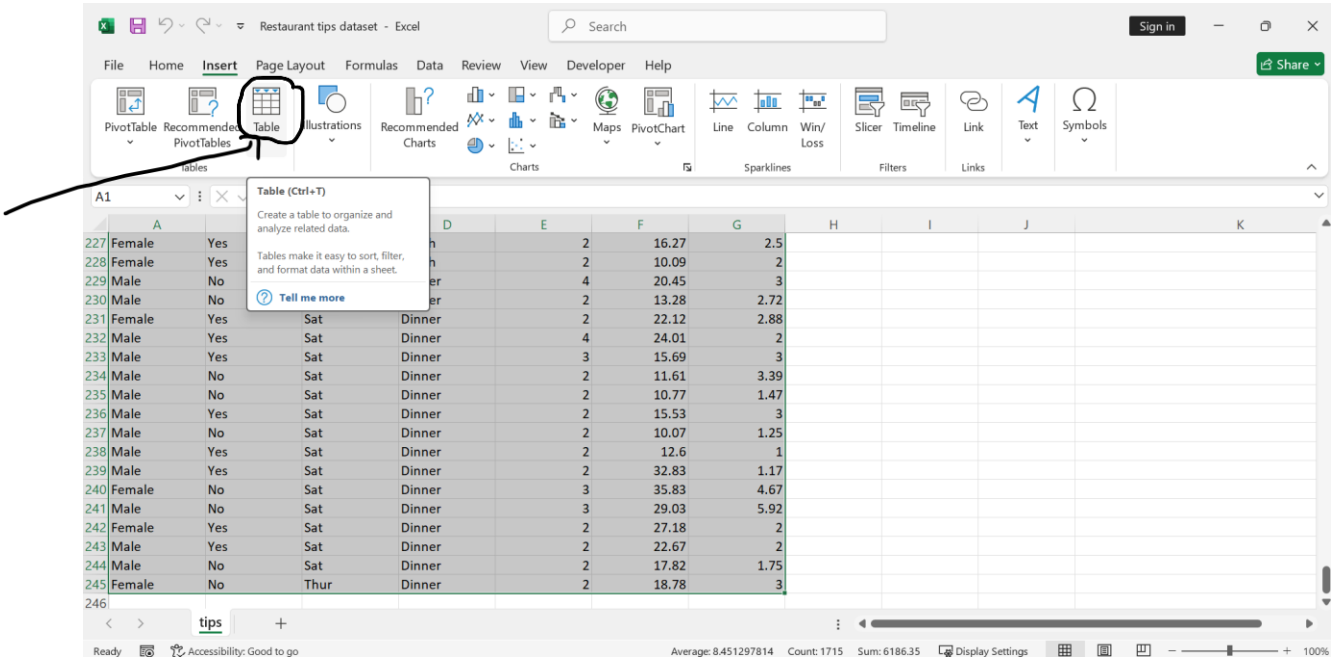
Find out if there are any missing values and clean the data.

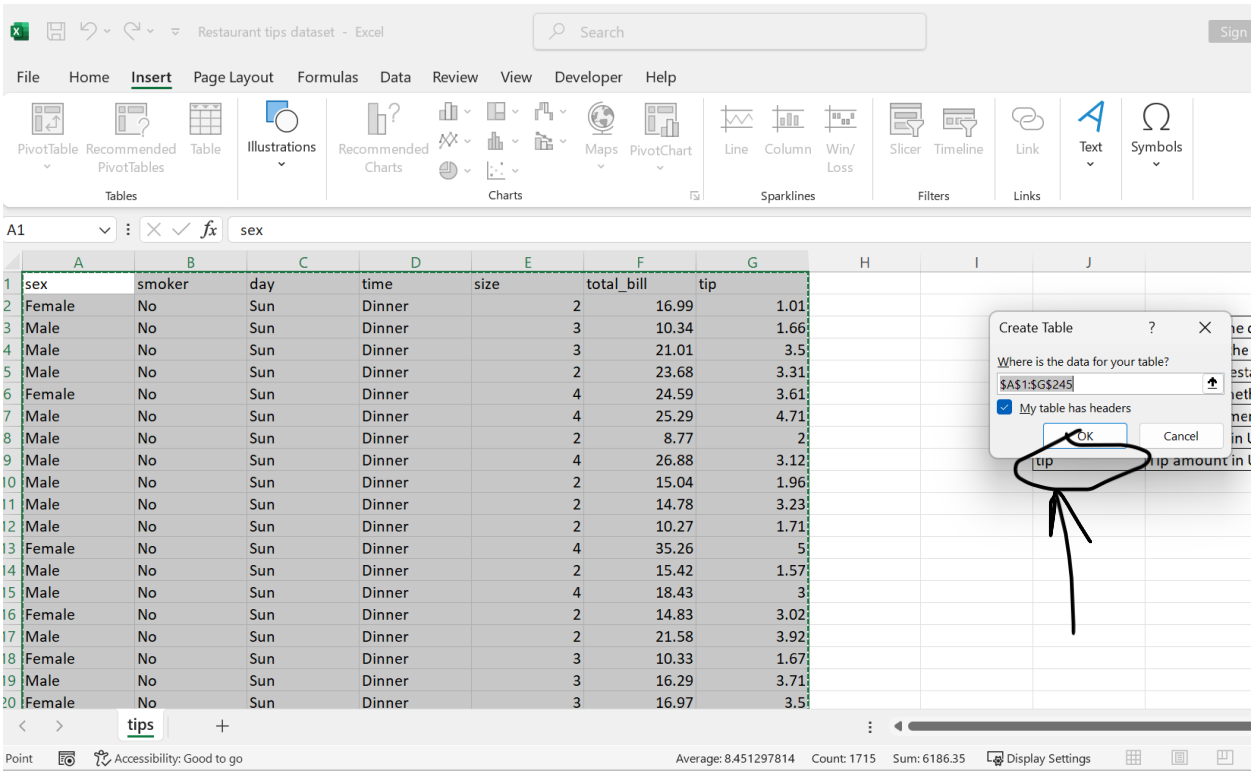
Solution:

- Open the data set in excel. Select the entire data and convert it into a **Table** from **Insert > Table**.

  Or

  Ctrl+T.

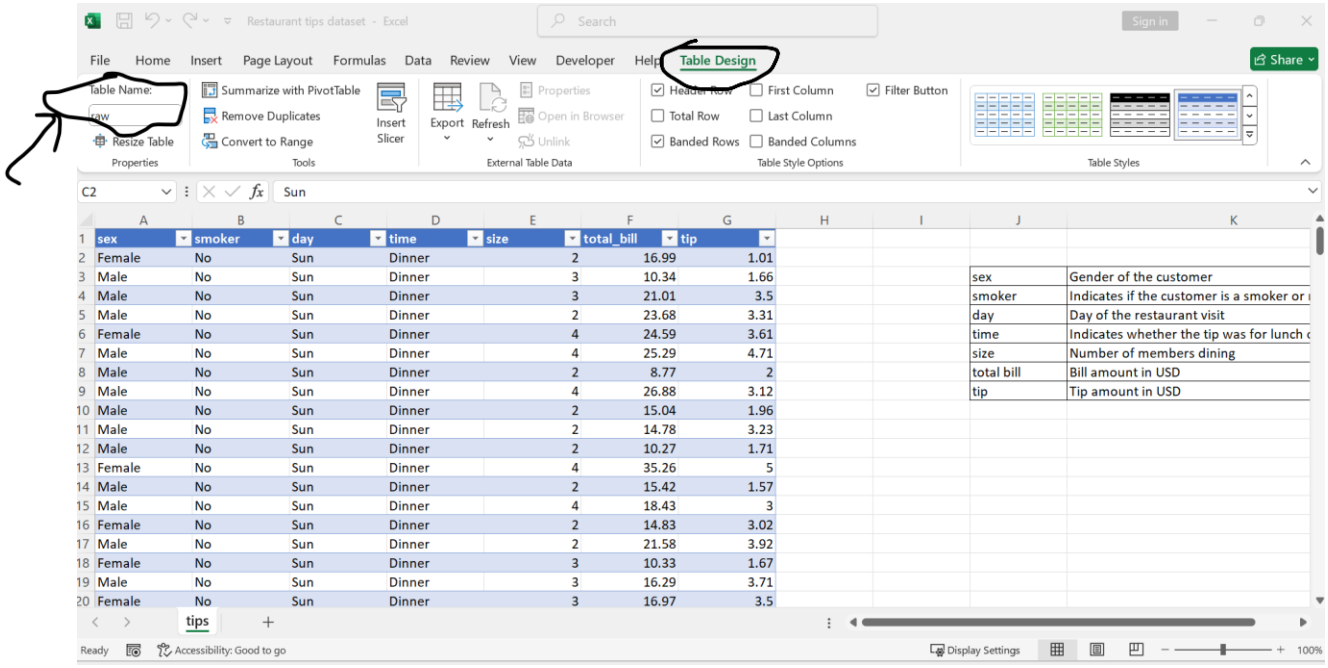




	A	B	C	D	E	F	G
1	sex	smoker	day	time	size	total_bill	tip
2	Female	No	Sun	Dinner	2	16.99	1.01
3	Male	No	Sun	Dinner	3	10.34	1.66
4	Male	No	Sun	Dinner	3	21.01	3.5
5	Male	No	Sun	Dinner	2	23.68	3.31
6	Female	No	Sun	Dinner	4	24.59	3.61
7	Male	No	Sun	Dinner	4	25.29	4.71
8	Male	No	Sun	Dinner	2	8.77	2
9	Male	No	Sun	Dinner	4	26.88	3.12
10	Male	No	Sun	Dinner	2	15.04	1.96
11	Male	No	Sun	Dinner	2	14.78	3.23
12	Male	No	Sun	Dinner	2	10.27	1.71
13	Female	No	Sun	Dinner	4	35.26	5
14	Male	No	Sun	Dinner	2	15.42	1.57
15	Male	No	Sun	Dinner	4	18.43	3
16	Female	No	Sun	Dinner	2	14.83	3.02
17	Male	No	Sun	Dinner	2	21.58	3.92
18	Female	No	Sun	Dinner	3	10.33	1.67
19	Male	No	Sun	Dinner	3	16.29	3.71
20	Female	No	Sun	Dinner	3	16.97	3.5

- Name the tables as **raw**. Select the

tabledesign >Properties>Table Name.



	A	B	C	D	E	F	G
1	sex	smoker	day	time	size	total_bill	tip
2	Female	No	Sun	Dinner	2	16.99	1.01
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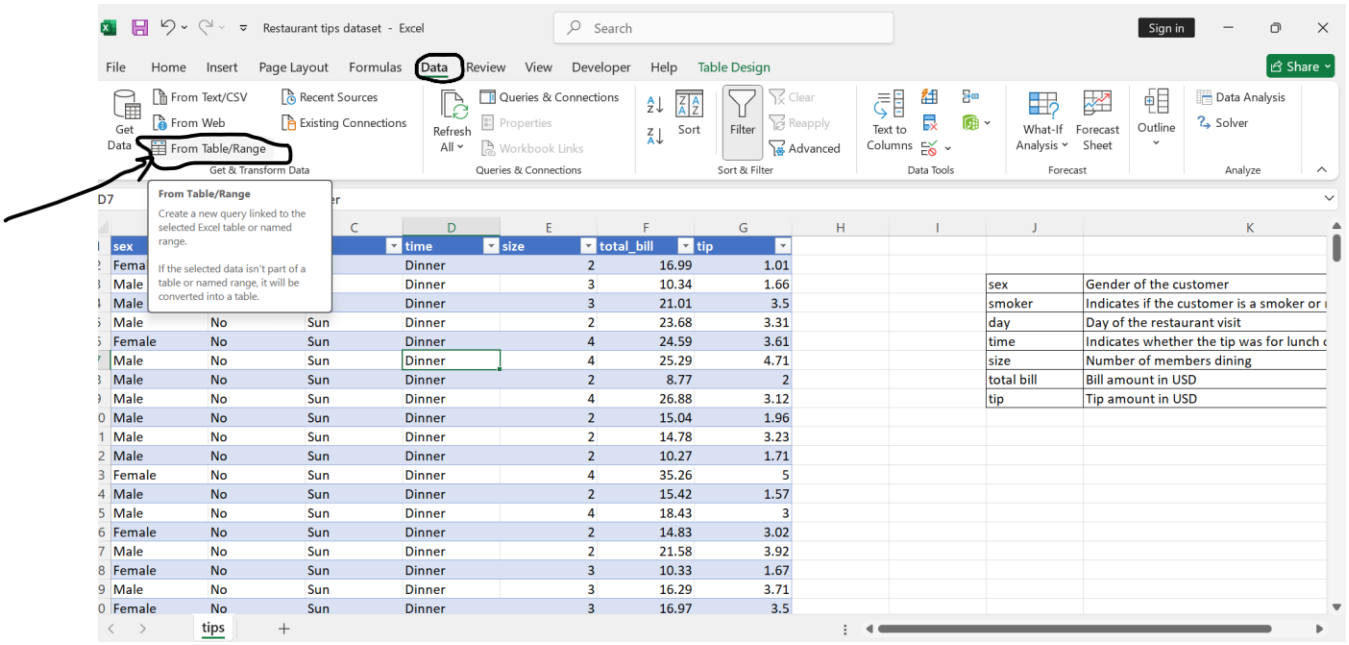
18	Female	No	Sun	Dinner	3	10.33	1.67
19	Male	No	Sun	Dinner	3	16.29	3.71
20	Female	No	Sun	Dinner	3	16.97	3.5

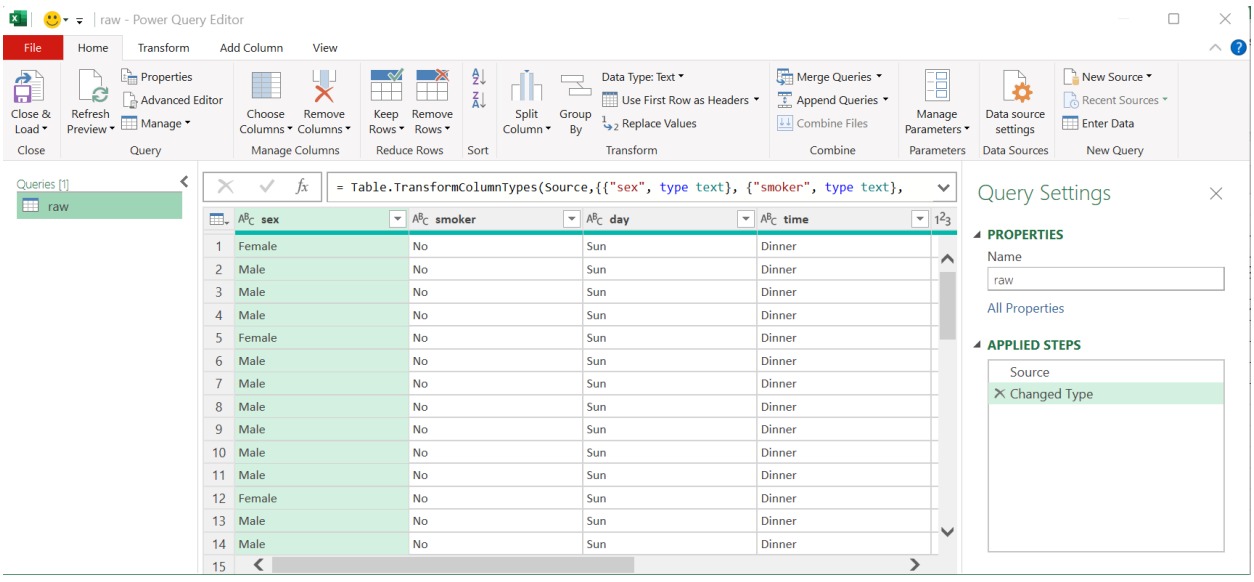
sex	Gender of the customer
smoker	Indicates if the customer is a smoker or
day	Day of the restaurant visit
time	Indicates whether the tip was for lunch
size	Number of members dining
total bill	Bill amount in USD
tip	Tip amount in USD

- Data cleaning will be done in Power Query. Select any cell in the

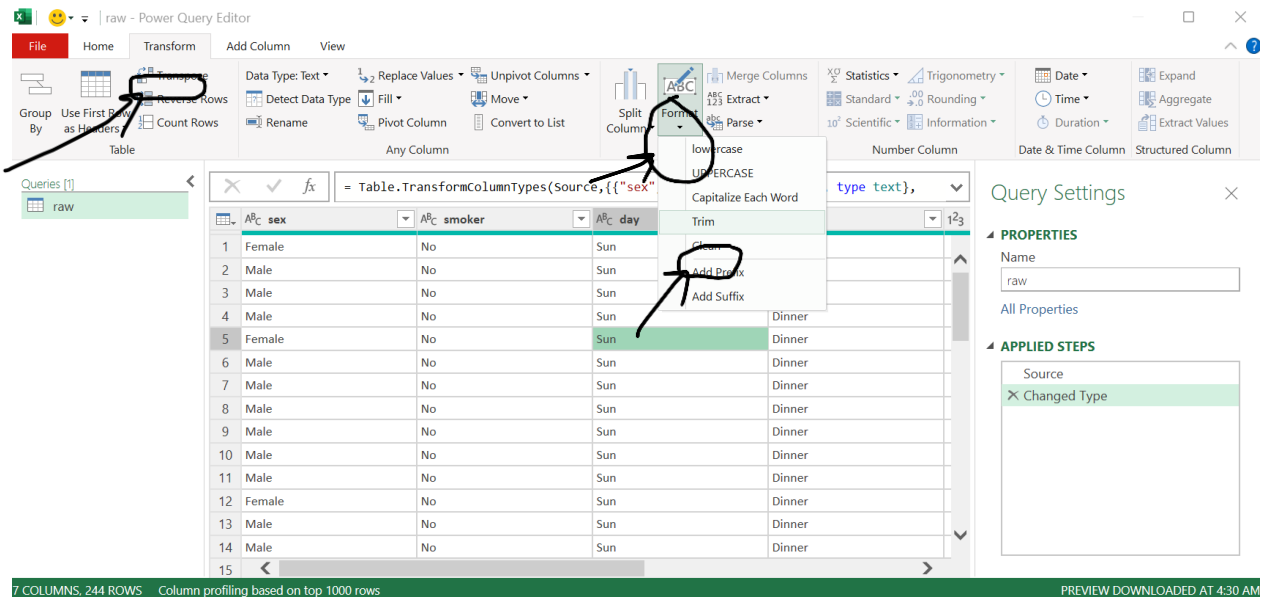
  table>Data>From Table/Range



After click on From Table/Range open like below:

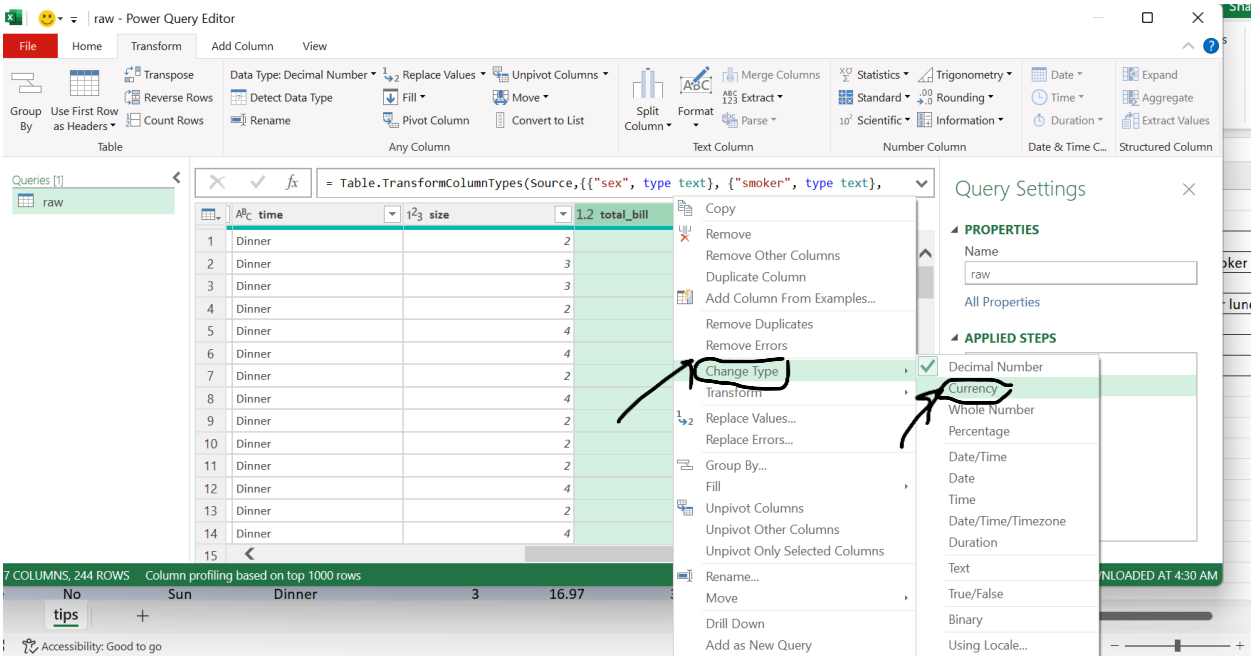


- Trimming extra spaces: **CTRL+A >Transform>Format>Trim**



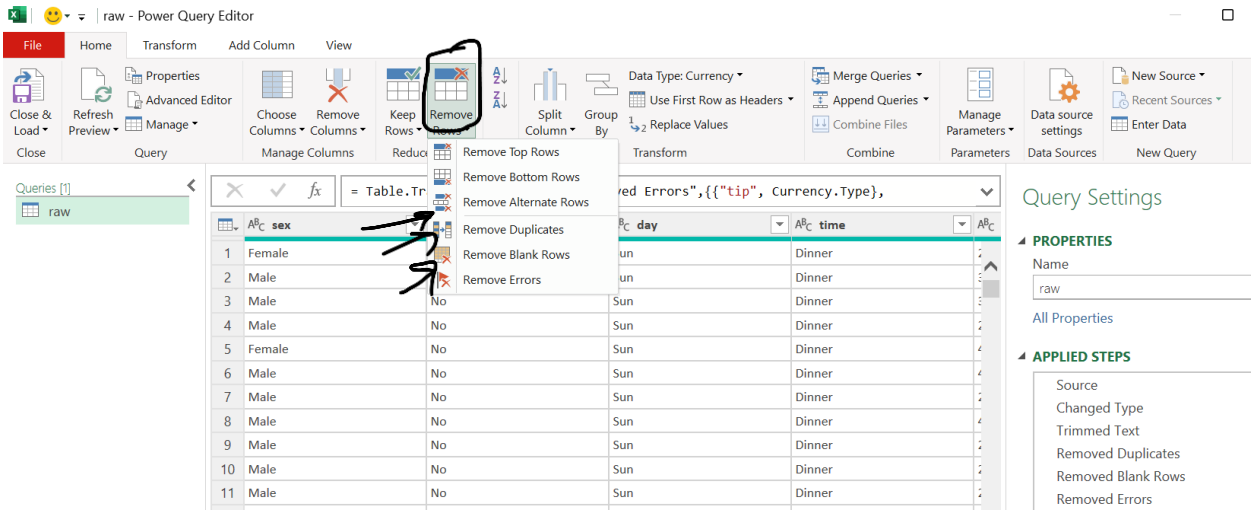
- Changing data types appropriately for columns:

Selecting the column for data type change ->Changes Type (total_bill and tips columns to Currency)



- Removing rows with **duplicates**, **errors**, **blank rows**:

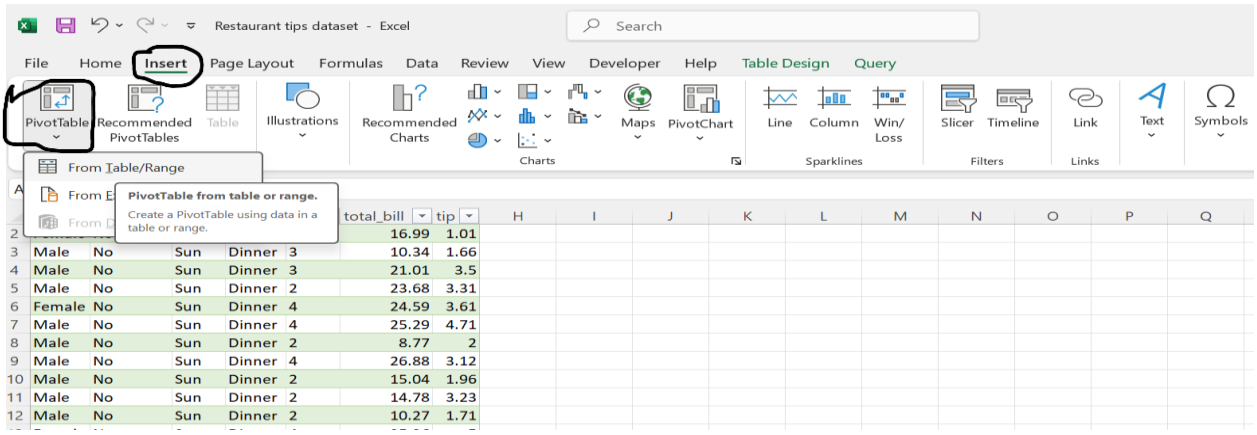
CTRL+A>Home>Remove Rows

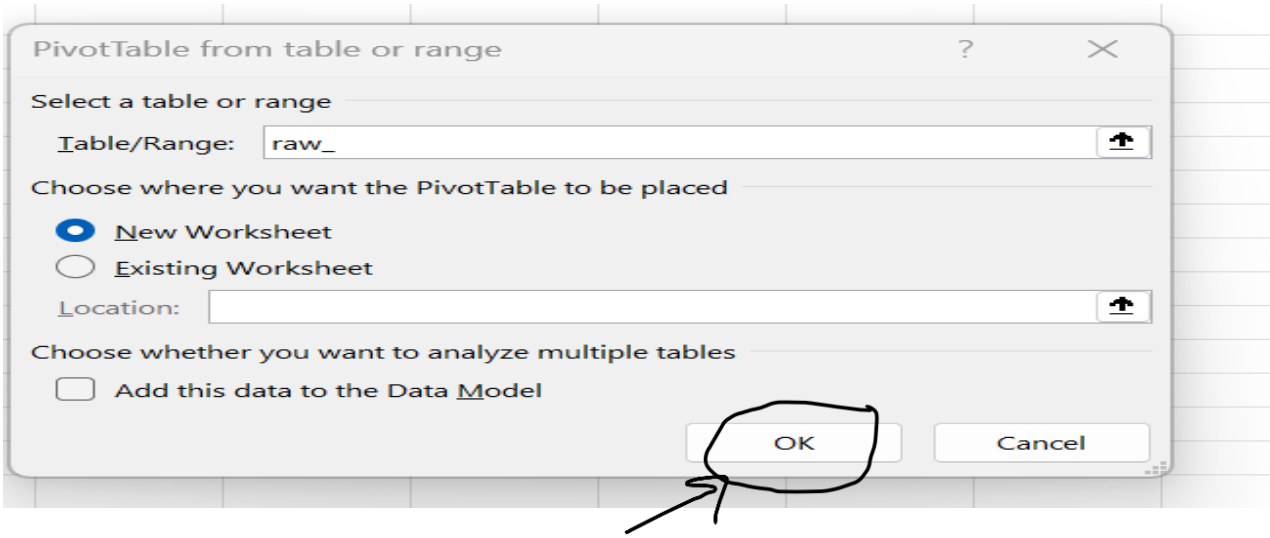


Exploratory Data Analysis:

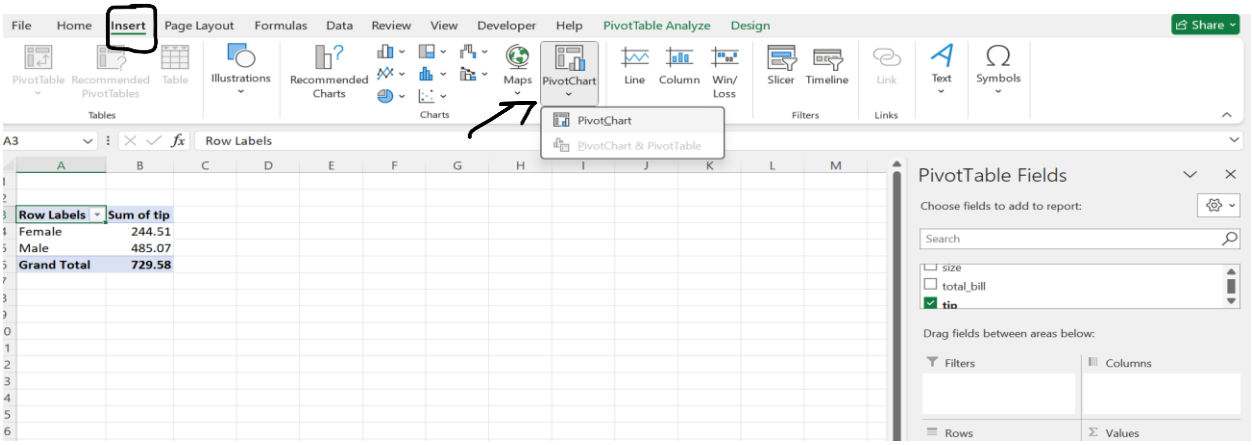
This step helps in understanding the data, finding patterns and anomalies through descriptive statistics and visualizations.

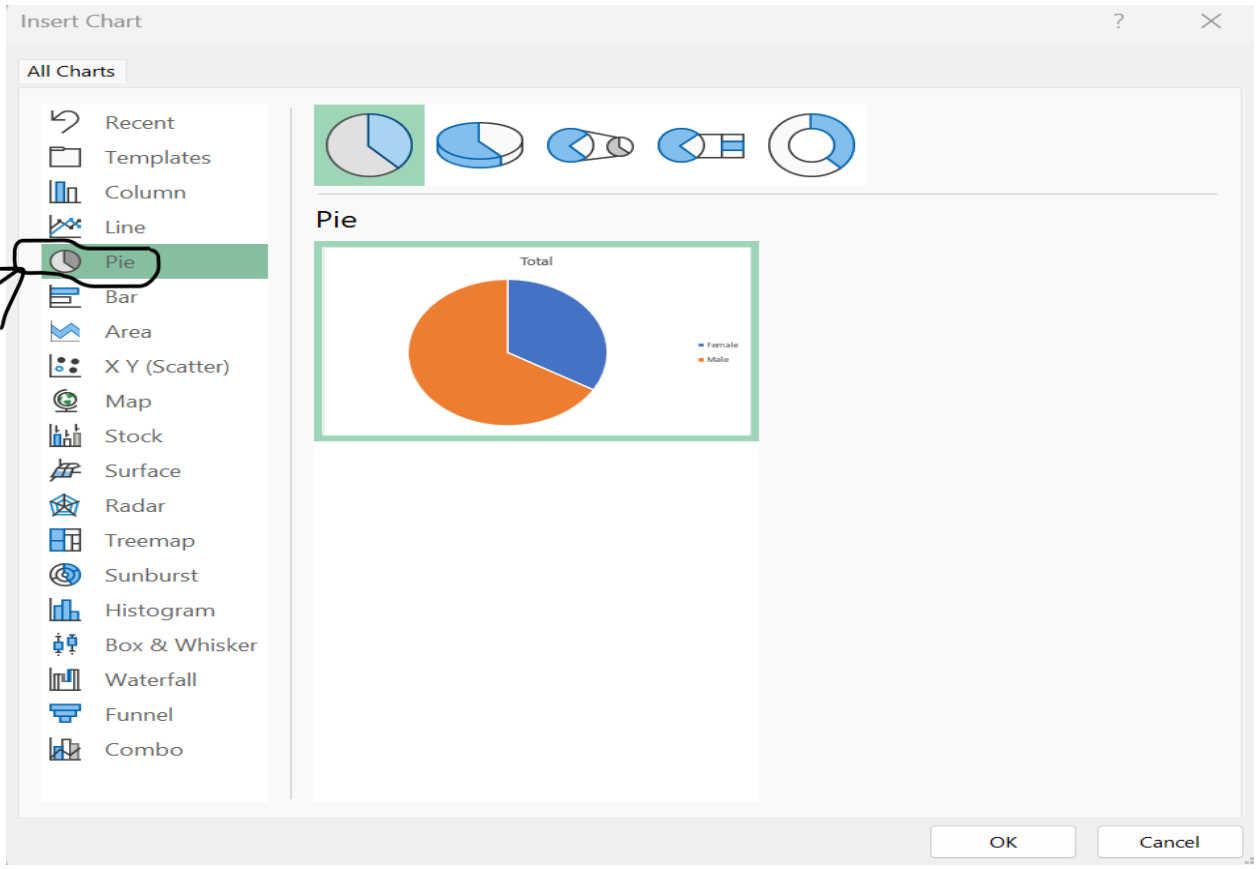
We'll use pivot tables to analyze and understand the patterns in our data. **Insert>Pivot tables>raw.**





1. Tips by Sex: sex in rows, tips in values. Add a pie chart; **click on insert -> PivotChart -> Pie chart.**

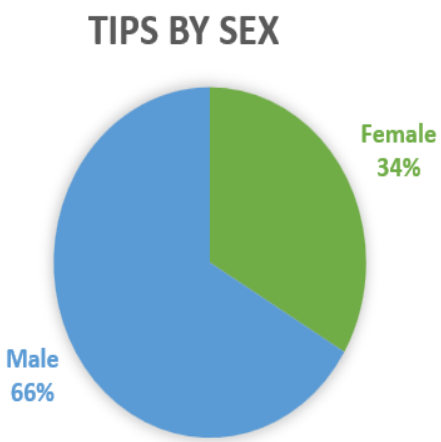




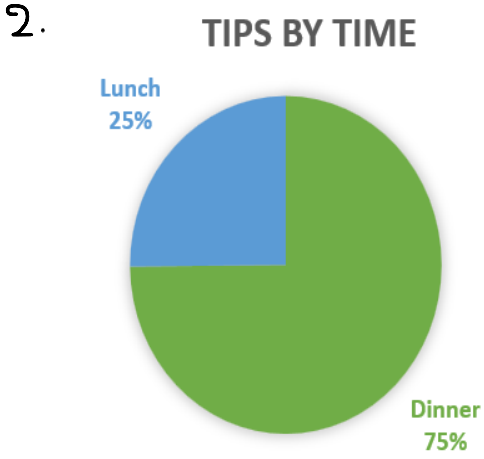
2. Tips by Time: time in rows, tips in values. Add a pie chart.

Output:

1.



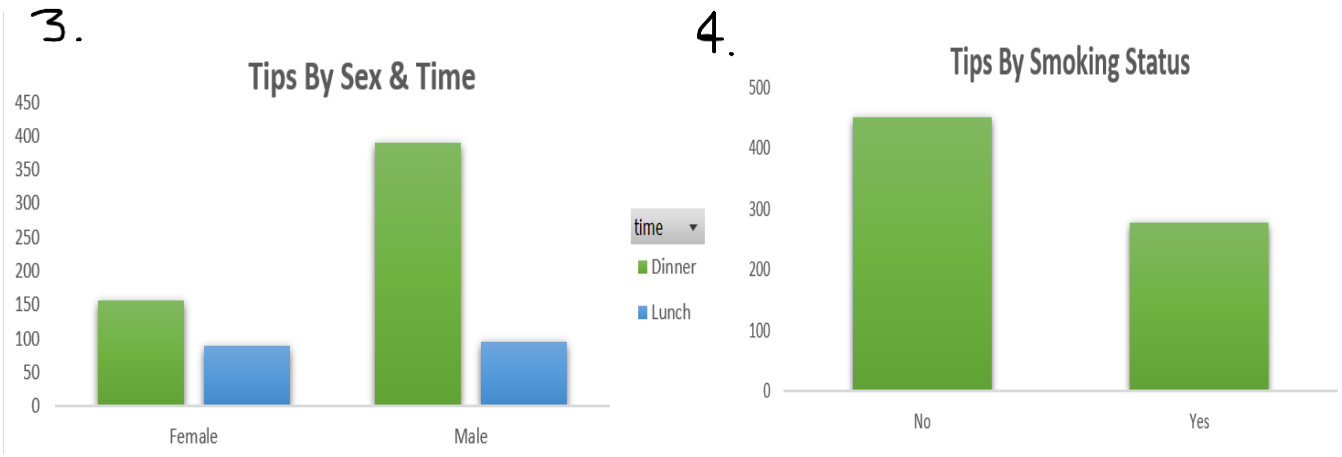
2.



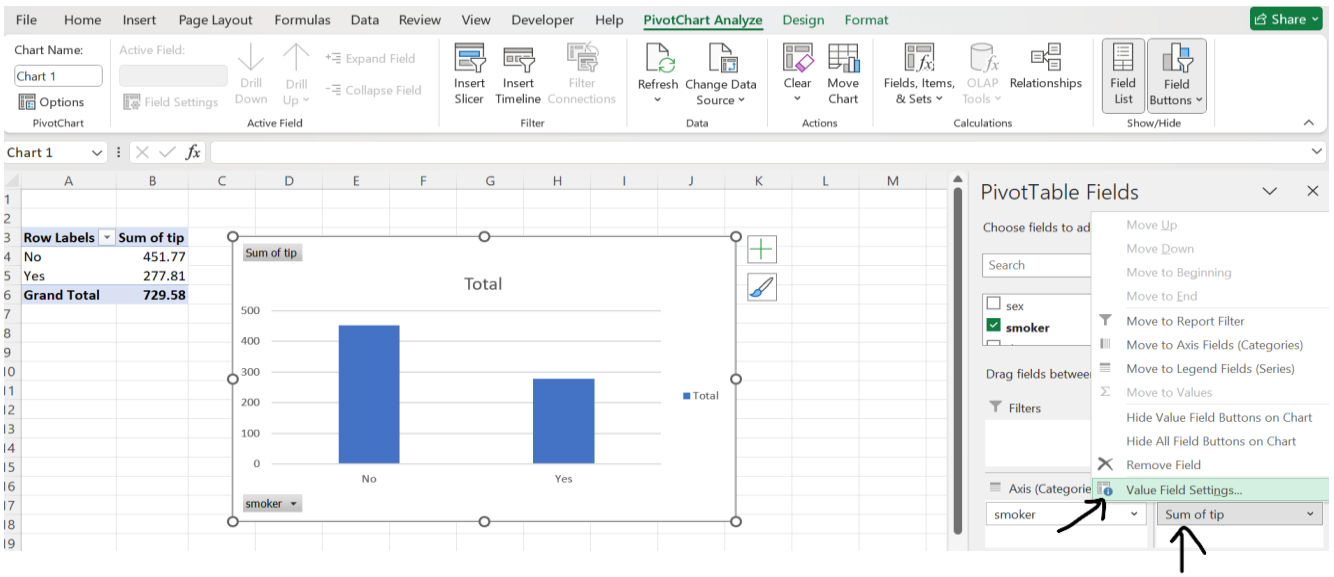
3. Tips by Sex and Time: sex in rows, time in columns, tips in values. Add a column chart.

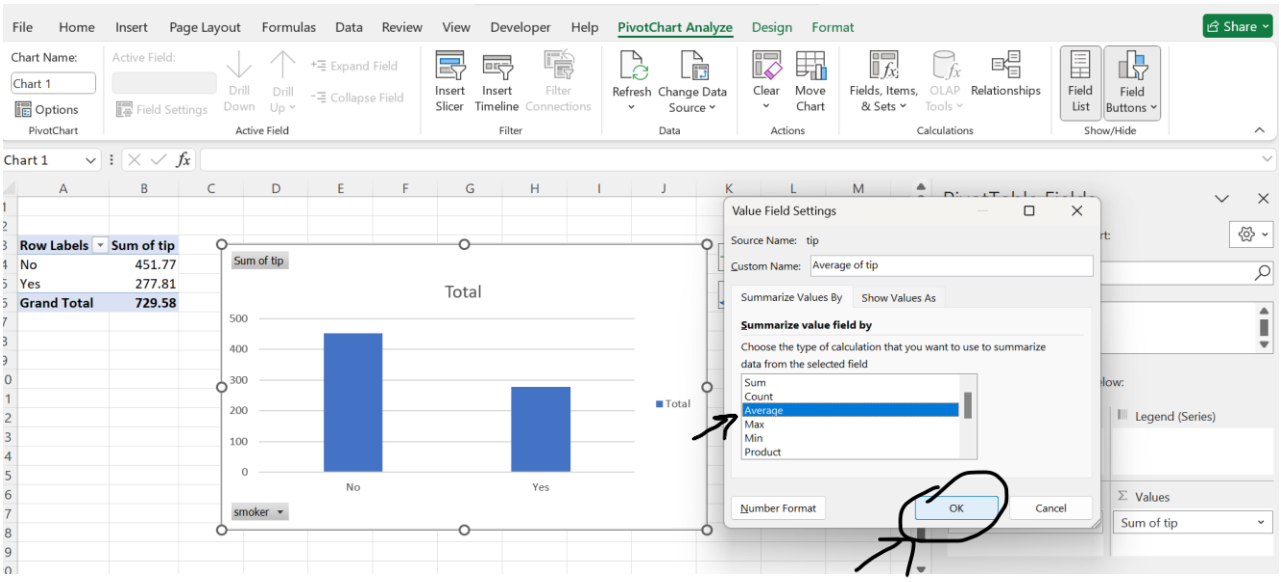
4. Tips by Smoking Status: smoker in rows, tips in values. Add a column chart.

Output:



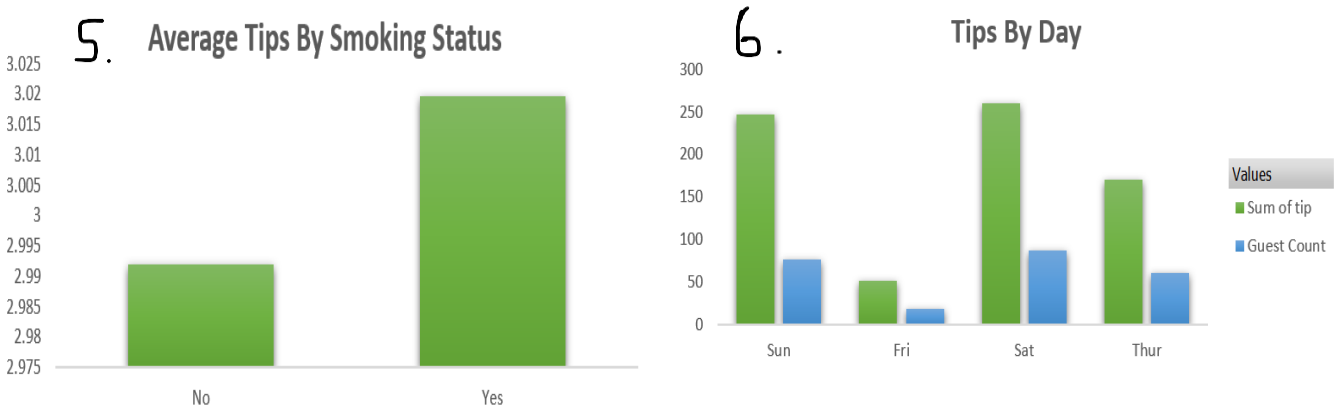
5. Average Tips by Smoking Status: smoker in rows, tips in values. Add a column chart. **PivotTable Fields>Values->Click Sum of Tip->Value Field Settings->Summarize value fields by>Average->OK.**





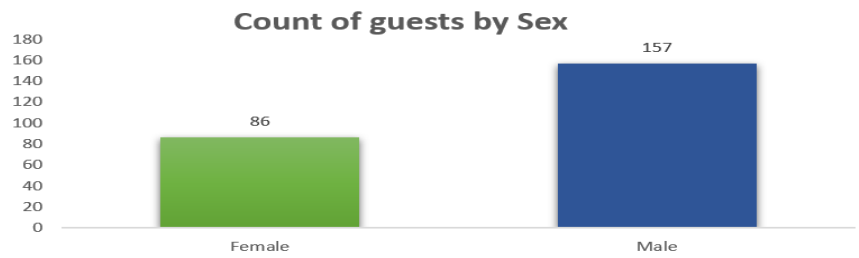
6. Tips By Day: day in rows, sum of tip and count of in values. Add a column chart.

Output:



7. Count of guests by Sex: sex in rows, sex in values.

Output:



Insights:

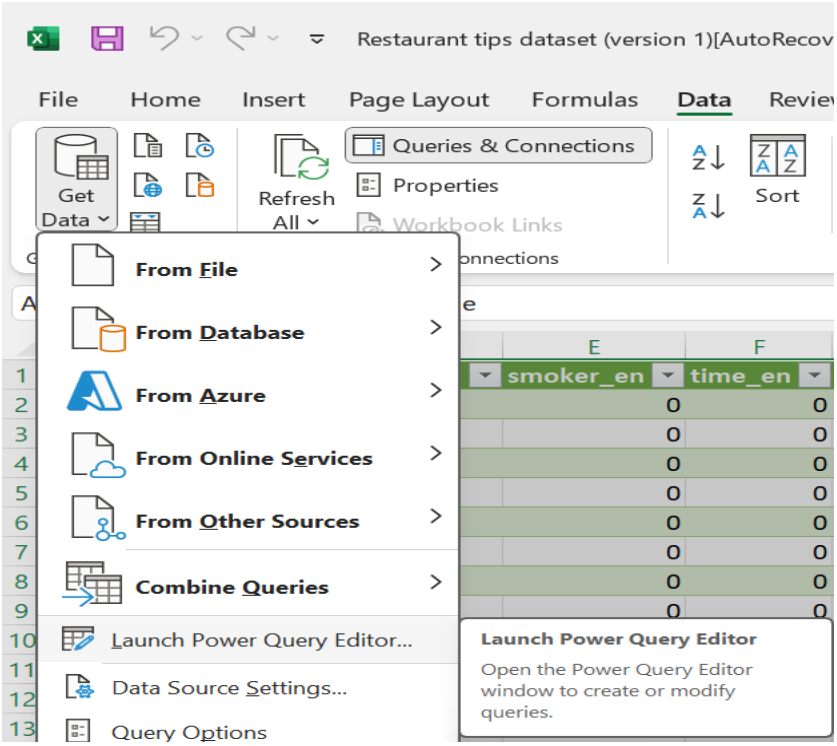
- From the Tips by Sex graph, it seems like men tend to give more tips than women.
- Tips received during dinner time are higher than lunch time but really, more people are visiting during dinner time. The size of guests at a table is almost the same for dinner and lunch time.
- The total tips given is higher by non-smokers but the average tips given by smokers is higher. Indicating that the number of non-smoker guests is higher but smokers tend to tip more.
- Guests tend to tip more during weekends.
- As the total bill of the table increases the tips also increases.

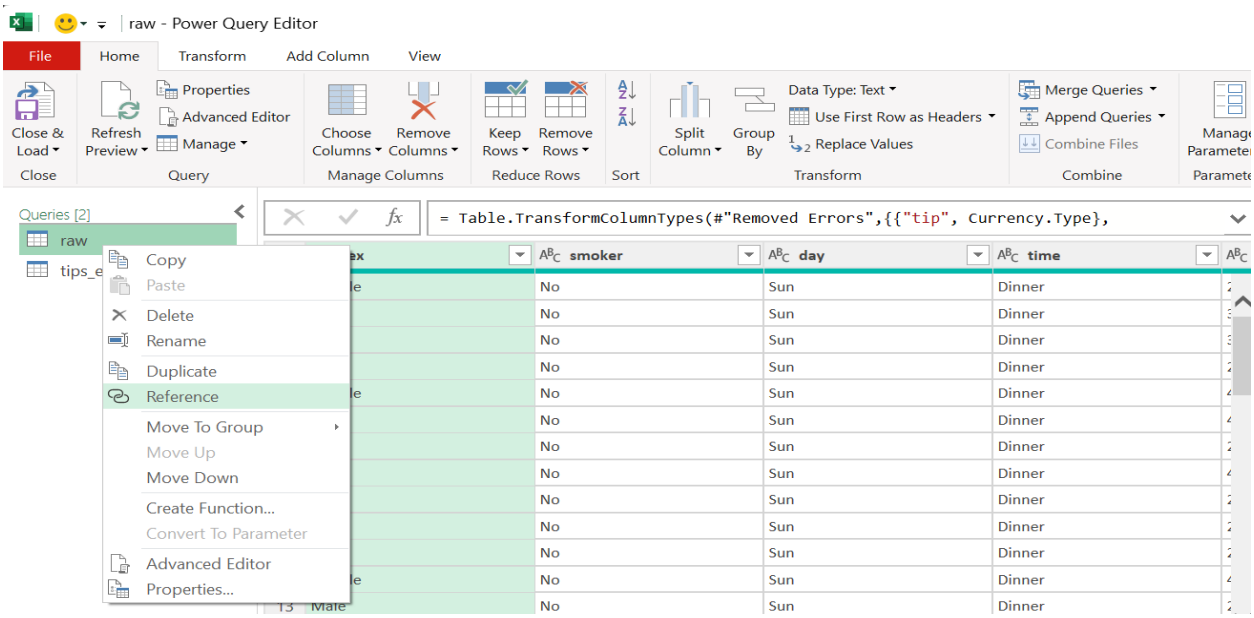
Feature Engineering:

- It's a process of creating new features or modifying existing ones to improve the performance of models. Features are nothing but independent variables.
- In this step, we will use Power Query to convert categorical columns into a numeric format, ensuring compatibility for model training. because model training can't be done with categorical values.
- Instead of modifying the original query, we will create a reference query. This allows the new query to link to the original, ensuring that any updates made to the original query are automatically reflected in the reference query.

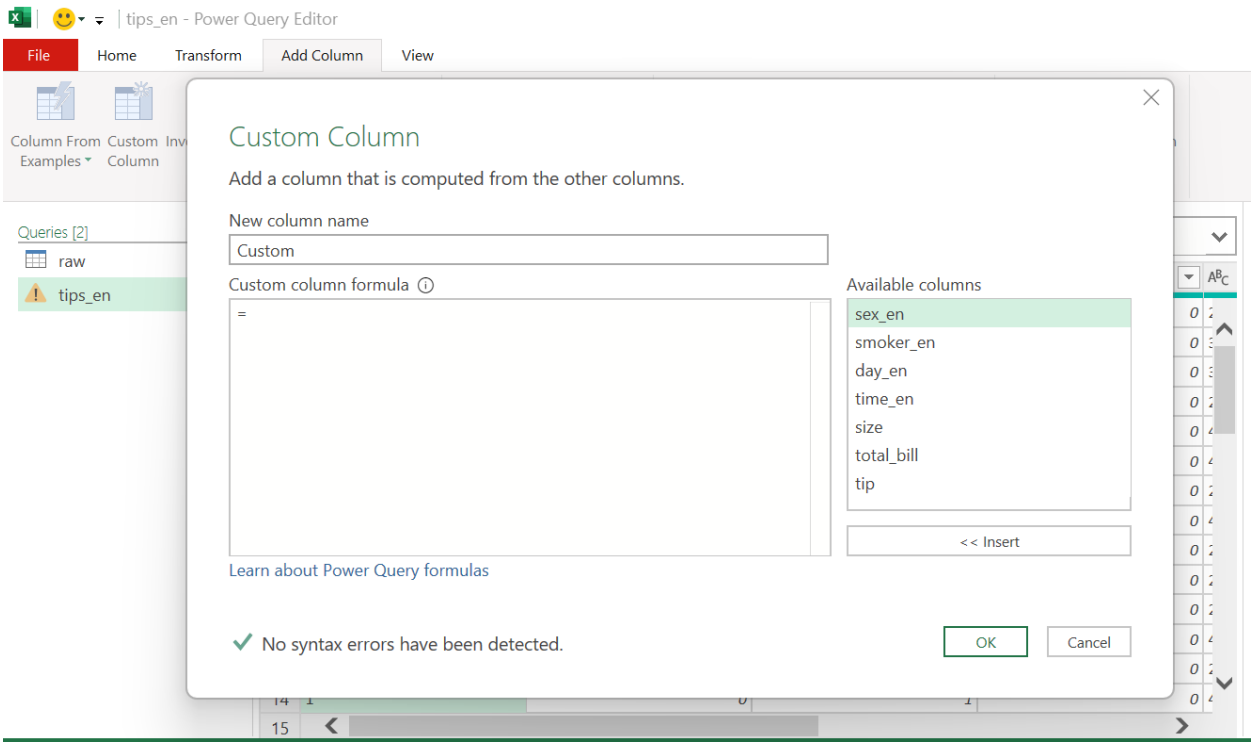
Steps: to add reference query

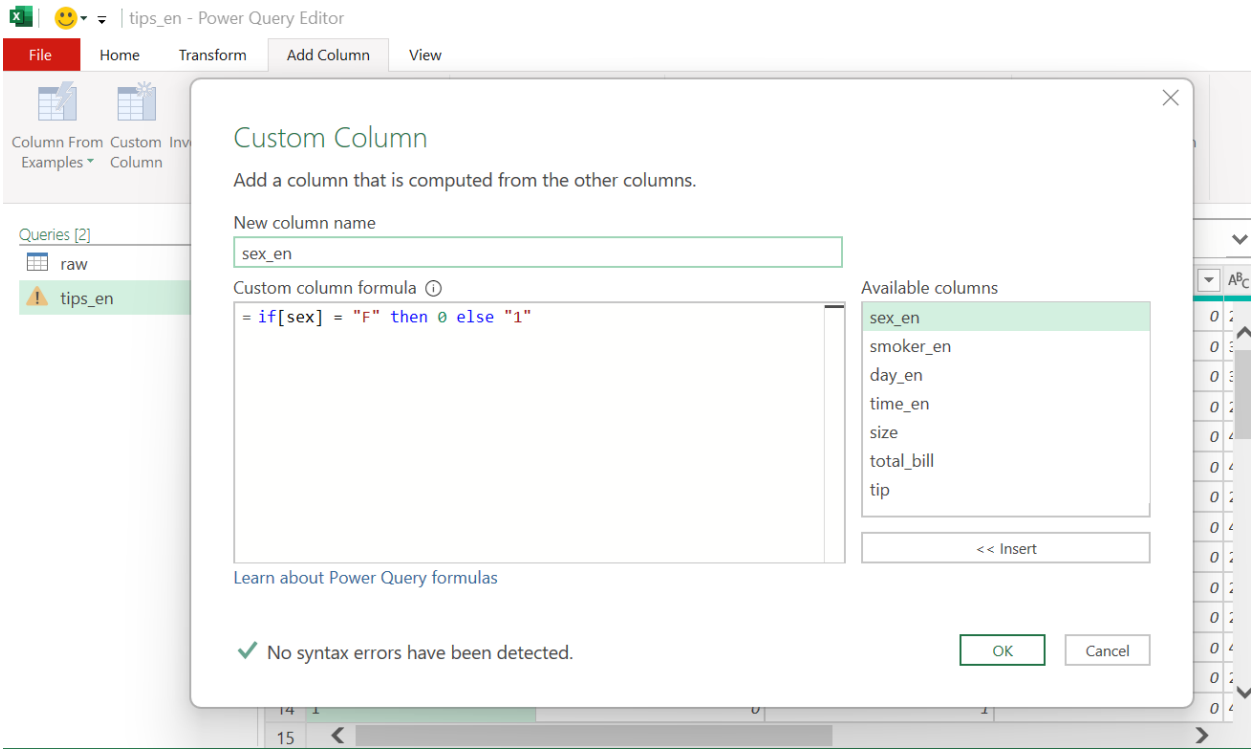
- **Open Power Query:** Go to the **data** tab -> click on **get data ->** click on **launch power query ->** Right click on the existing query **(raw) ->** click on **Reference**





Right click on **reference (copy raw)->** click on **Add Column ->** click on **Custom Column**


tips_en - Power Query Editor
File
Home
Transform
Add Column
View
Column From Examples
Custom Column
Queries [2]
raw
tips_en
Custom Column
Add a column that is computed from the other columns.
New column name
Custom
Custom column formula
=
Available columns
sex_en
smoker_en
day_en
time_en
size
total_bill
tip
<< Insert
Learn about Power Query formulas
No syntax errors have been detected.
OK
Cancel


tips_en - Power Query Editor
File
Home
Transform
Add Column
View
Column From Examples
Custom Column
Queries [2]
raw
tips_en
Custom Column
Add a column that is computed from the other columns.
New column name
sex_en
Custom column formula
= if[sex] = "F" then 0 else "1"
Available columns
sex_en
smoker_en
day_en
time_en
size
total_bill
tip
<< Insert
Learn about Power Query formulas
No syntax errors have been detected.
OK
Cancel

Sex: if[sex] = "F" then 0 else "1" (write this query in custom column formula) then change custom (new column name) in to “sex_en”

Repeat for all the categorical columns

Smoker: No = 0, Yes = 1. **Custom column formula:** if[smoker] = " No" then 0 else "1"

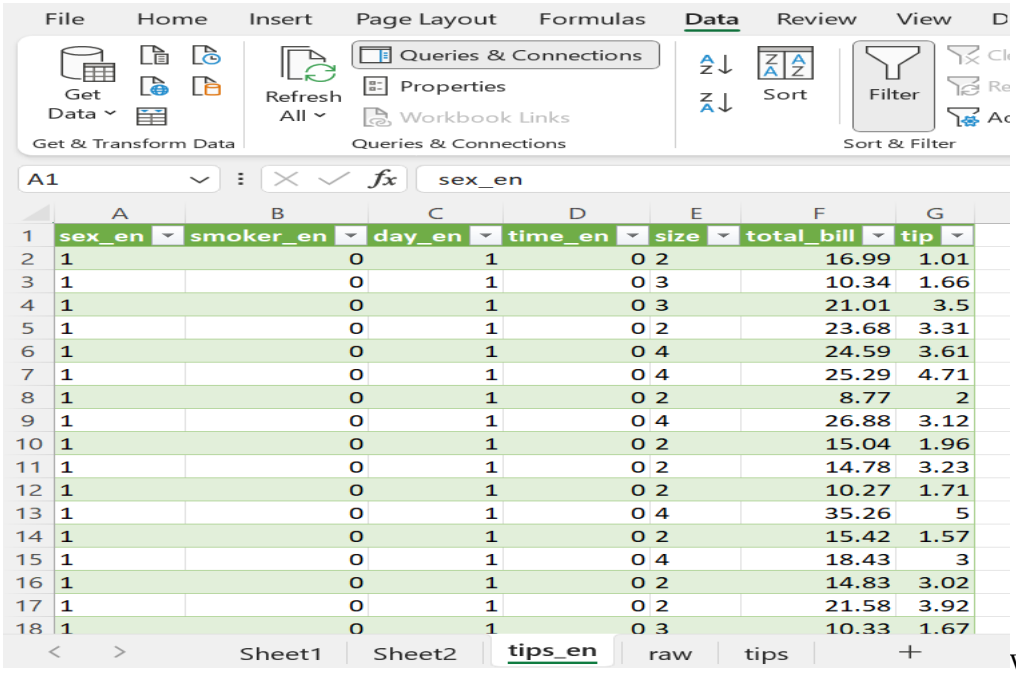
Time: Dinner = 0, Launch = 1. **Custom column formula:** if[time] = " Dinner" then 0 else "1"

Day: For Sunday to Saturday use 1 to 7 respectively. **Custom column formula:** If[day] = “sun” then 1 else if [day] = “Mon” then 2 else if [day] = “Tue” then 3 else if [day] = "Wed" then 4 else if [day] = "Thu" then 5 else if [day] = "Fri" then 6 else if [day] = "Sat" then 7 else null

Remove the original columns sex, smoker, time, day columns (right click on column then -> click on **remove**)

Reorder the columns similar to the original table. **Rename the table as “tips_en” -> Close and Load(keep).**

Final look of “tips_en” will be:



	A	B	C	D	E	F	G
1	sex_en	smoker_en	day_en	time_en	size	total_bill	tip
2	1	0	1	0	2	16.99	1.01
3	1	0	1	0	3	10.34	1.66
4	1	0	1	0	3	21.01	3.5
5	1	0	1	0	2	23.68	3.31
6	1	0	1	0	4	24.59	3.61
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8	1	0	1	0	2	8.77	2
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12	1	0	1	0	2	10.27	1.71
13	1	0	1	0	4	35.26	5
14	1	0	1	0	2	15.42	1.57
15	1	0	1	0	4	18.43	3
16	1	0	1	0	2	14.83	3.02
17	1	0	1	0	2	21.58	3.92
18	1	0	1	0	3	10.33	1.67

Sheet1 Sheet2 tips_en raw tips

working table

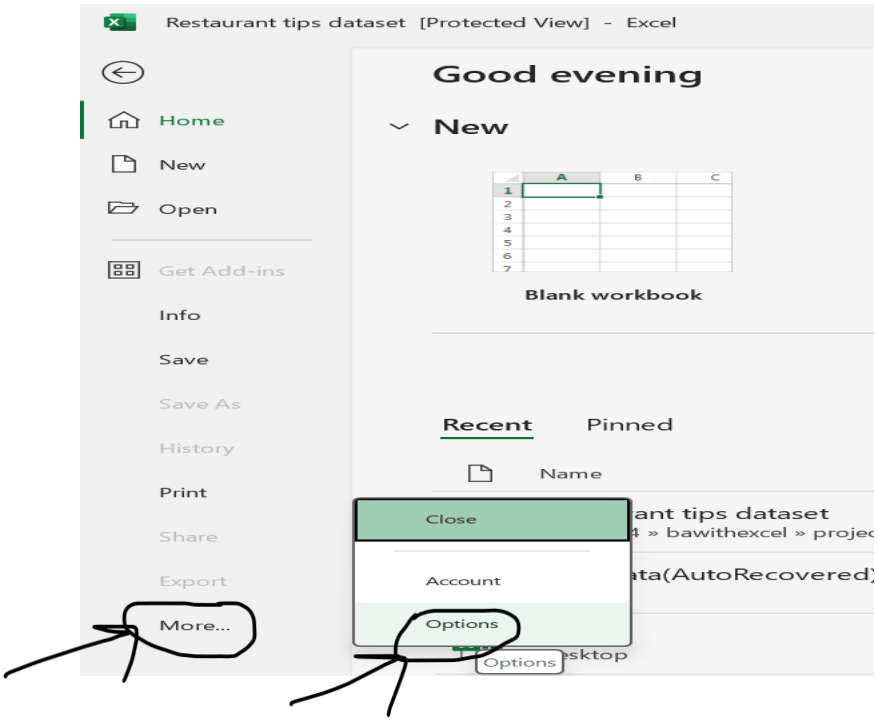
Note: From the next step forward, understanding of certain statistics concepts are necessary. Check out "*Understanding Multiple Linear Regression in Simple Terms*"

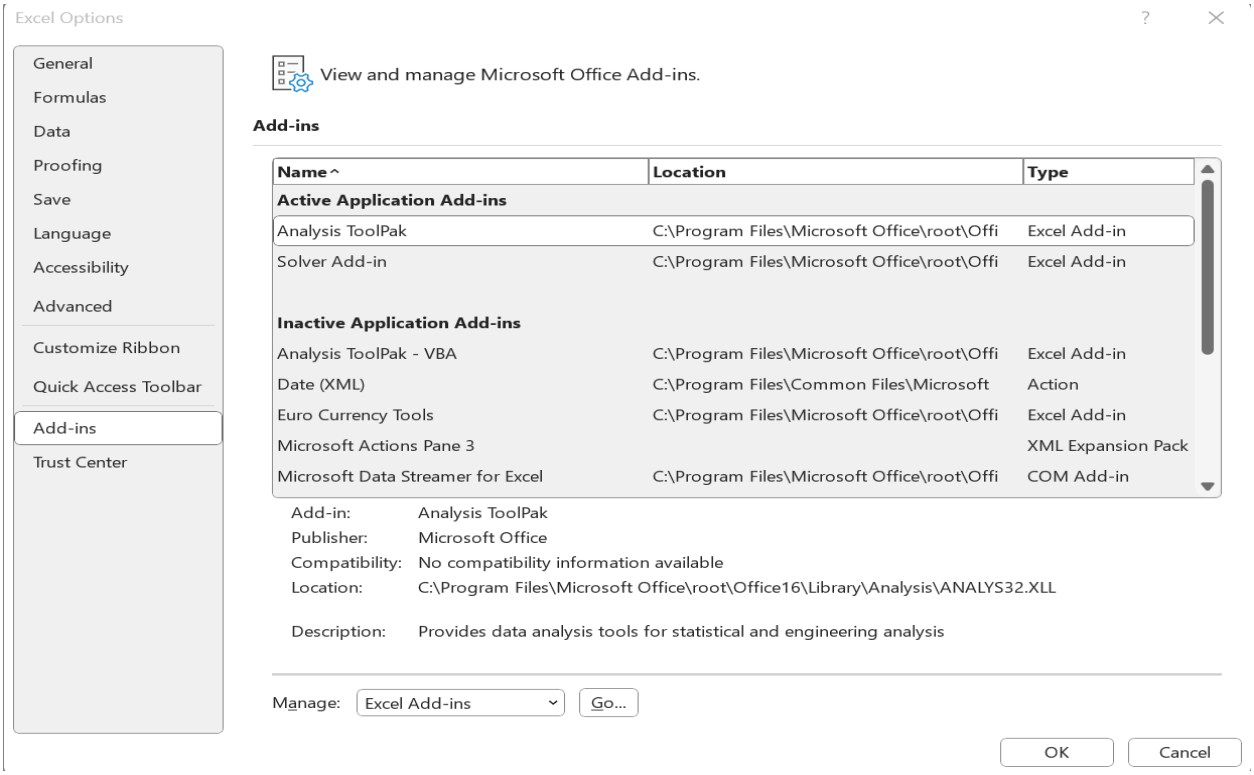
Feature Selection:

First, we will identify the independent and dependent variables for the regression model. Since our goal is to predict tips, the 'tips' column will be the dependent (target) variable, while all other columns will be independent variables (predictors)

Next, we will analyze covariance, correlation, and multicollinearity to help in selecting independent variables that have a strong relationship with the target variable while minimizing relationships with one another.

- ✓ For further steps make sure the "**Data Analysis Toolpak"** is added. If not go to **Files -> more -> Options -> Add-ins ->** Click on **Analysis ToolPak -> Manage**(at the bottom side) **-> Go -> Ok**

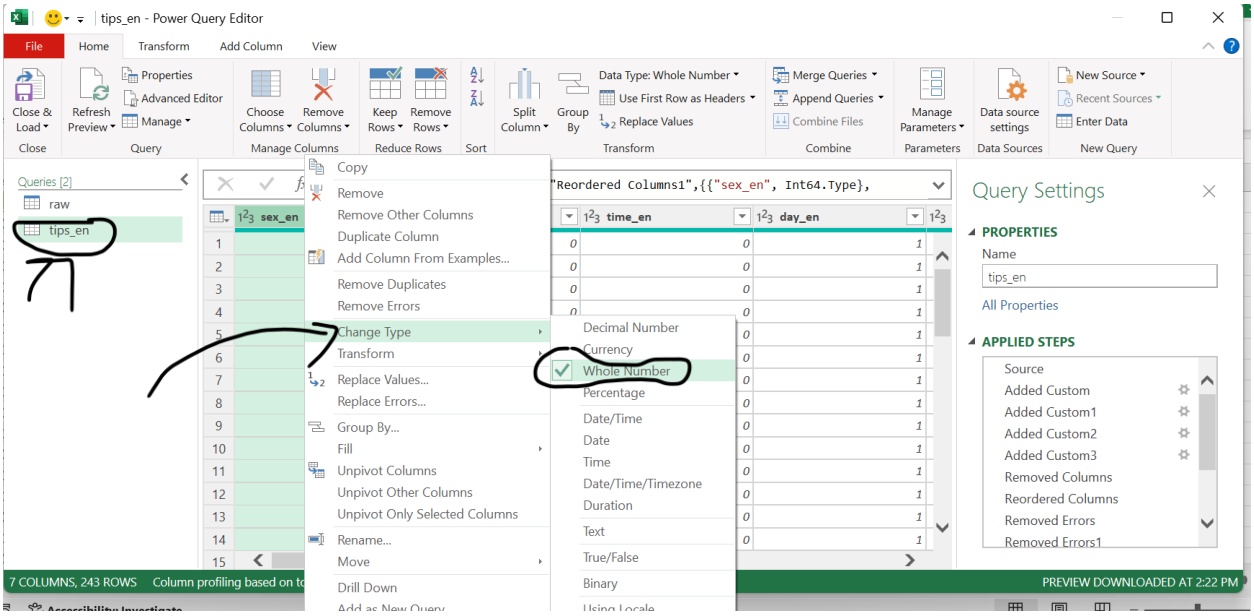




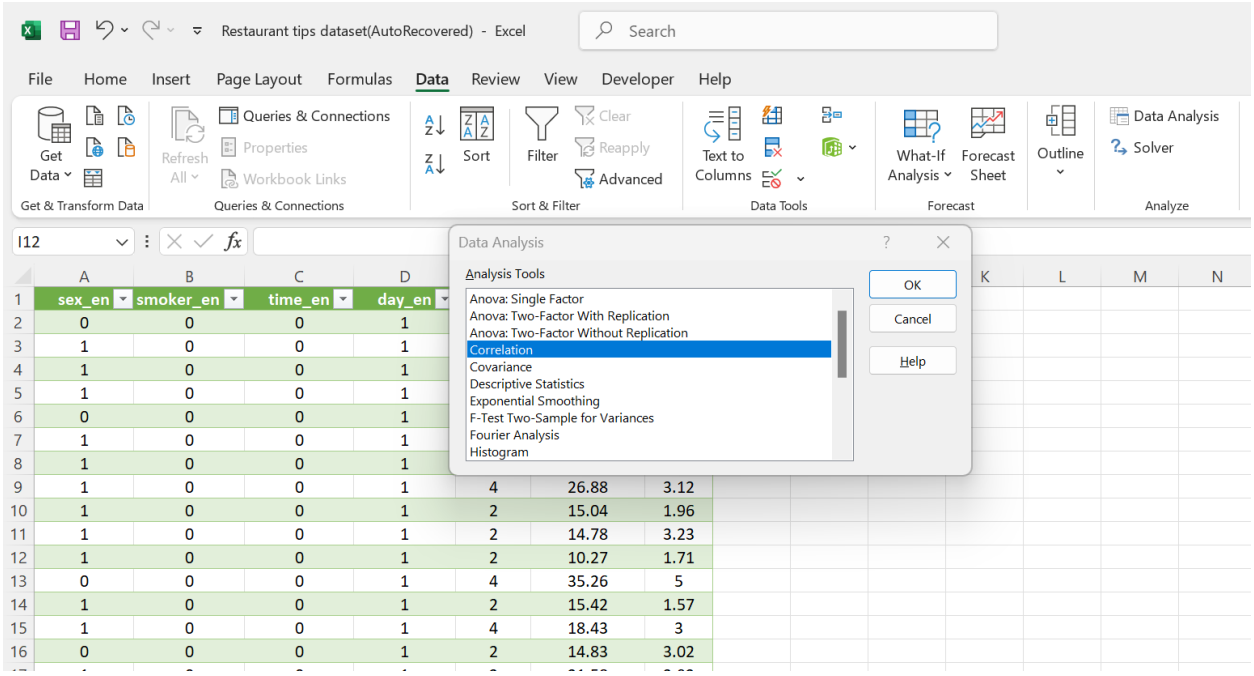
Now go to the **Data tab -> Data Analysis ->** click on **Correlation.** Input range is the entire table. (Make sure table is "**numeric**" to check: Select your dataset and press **Ctrl + G** → Click **Special** → Choose **Constants** → Uncheck everything except **Text** → Click **OK.)**

- **If Excel highlights any non-numeric values, either remove them or convert them to numbers.**

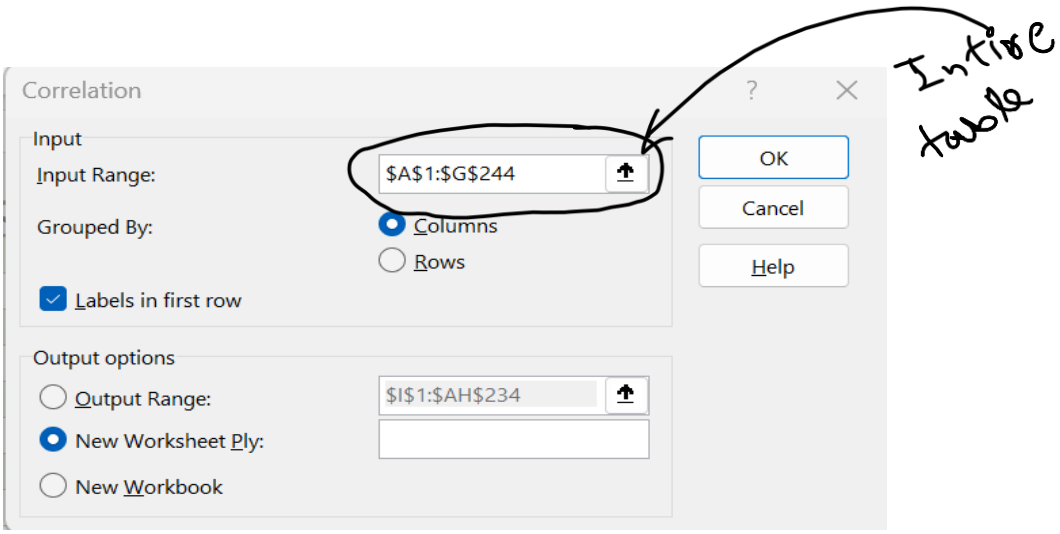
NOTE: If show **non-numeric values** then Go to the **-> get data ->** click on **launch power query editor ->** click on reference table **(tips_en) then** right click on **cell -> click on change type -> whole number. Repeat For all the columns.**



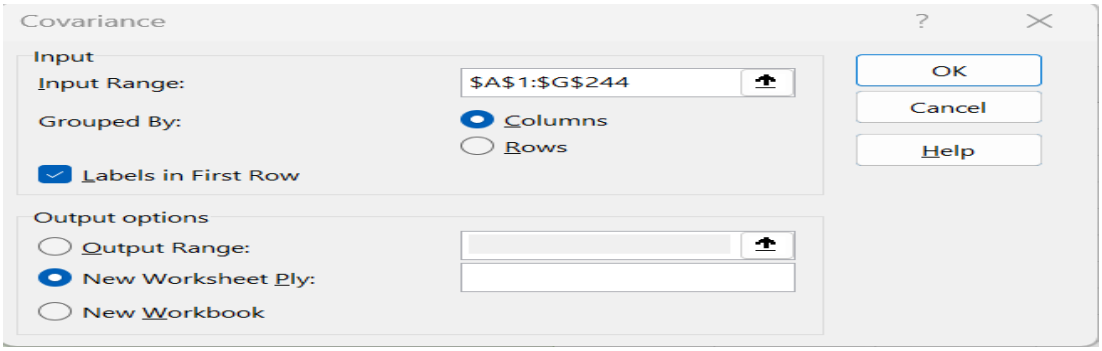
Correlation



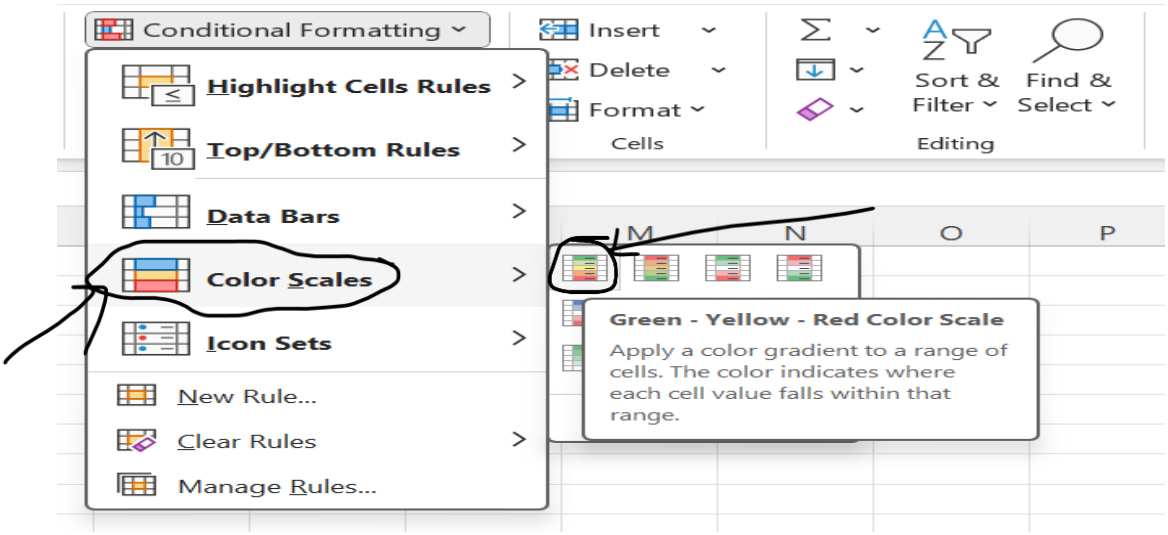
sex_en	smoker_en	time_en	day_en			
0	0	0	1			
1	0	0	1			
1	0	0	1			
1	0	0	1			
0	0	0	1			
1	0	0	1			
1	0	0	1			
1	0	0	1	4	26.88	3.12
1	0	0	1	2	15.04	1.96
1	0	0	1	2	14.78	3.23
1	0	0	1	2	10.27	1.71
0	0	0	1	4	35.26	5
1	0	0	1	2	15.42	1.57
1	0	0	1	4	18.43	3
0	0	0	1	2	14.83	3.02



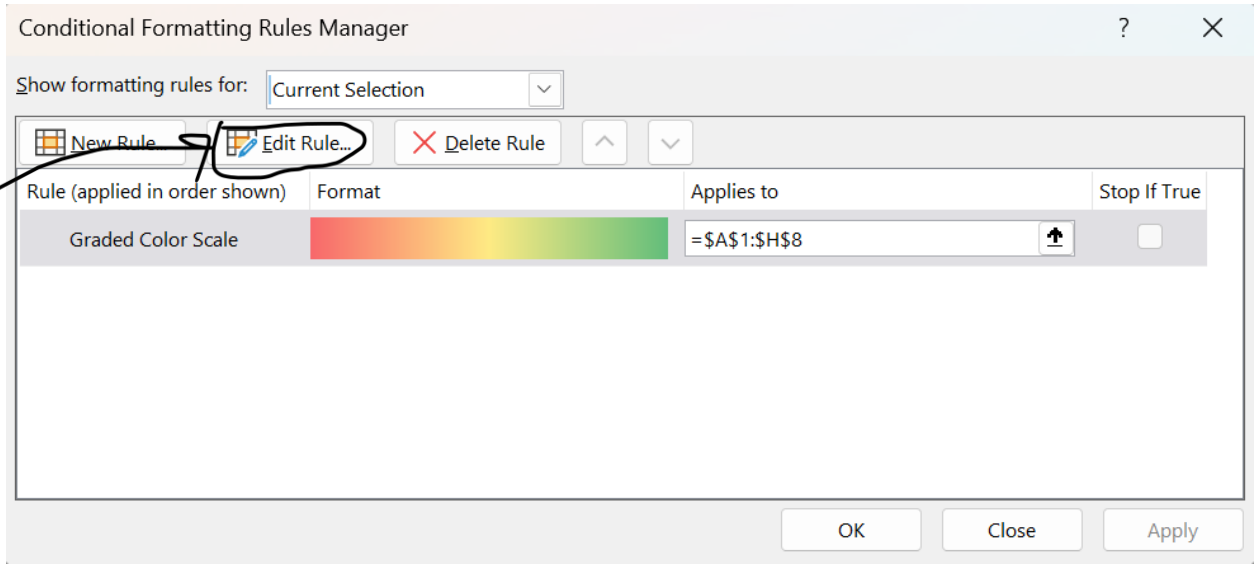
Do the same for covariance:



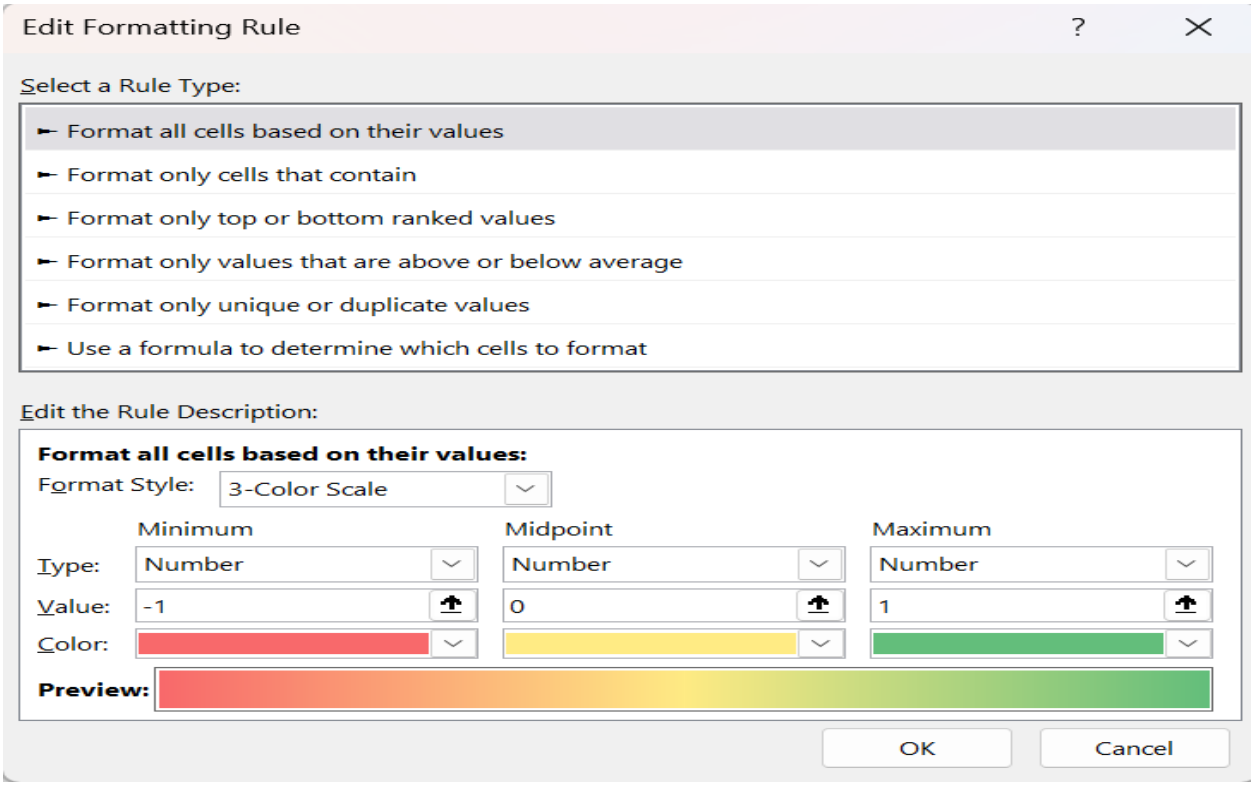
- Applying the conditional formatting for correlation **Home** -> click on **Conditional Formatting** -> click on **Color_Scales** -> **Pick whichever you like**



- **Home -> Conditional Formatting ->** click on **Manage Rules ->** Select Rule **Edit Rule**



- **Set Minimum, Midpoint, Maximum to -1, 0, 1,** since range of correlation is -1 to 1.



CORRLEATION TABLE OUTPUT WILL BE:

	A	B	C	D	E	F	G	H
1		*sex_en*	*smoker_en*	*time_en*	*day_en*	*size*	*total_bill*	*tip*
2	sex_en	1						
3	smoker_en	0.009930188	1					
4	time_en	-0.198128623	-0.063911231	1				
5	day_en	-0.110641838	0.219698794	0.137905919	1			
6	size	0.083248017	-0.130564411	-0.100045303	-0.17330627	1		
7	total_bill	0.141349744	0.090136102	-0.179231854	-0.078628796	0.597588931	1	
8	tip	0.085273975	0.00976275	-0.11759639	-0.099046544	0.488400395	0.674997857	1

COVARIANCE TABLE OUTPUT WILL BE:

	sex_en	*smoker_en*	*time_en*	*day_en*	*size*	*total_bill*	*tip*
sex_en	0.228657556						
smoker_en	0.002303172	0.23526224					
time_en	-0.04233772	-0.013852902	0.199698555				
day_en	-0.132855764	0.267591322	0.154752832	6.305746075			
size	0.037832986	-0.060187302	-0.042490135	-0.41360565	0.903249843		
total_bill	0.600998662	0.388741215	-0.712177683	-1.7556404	5.050009484	79.06265664	
tip	0.056359125	0.006544903	-0.072633406	-0.343765686	0.641556504	8.295509286	1.91033669

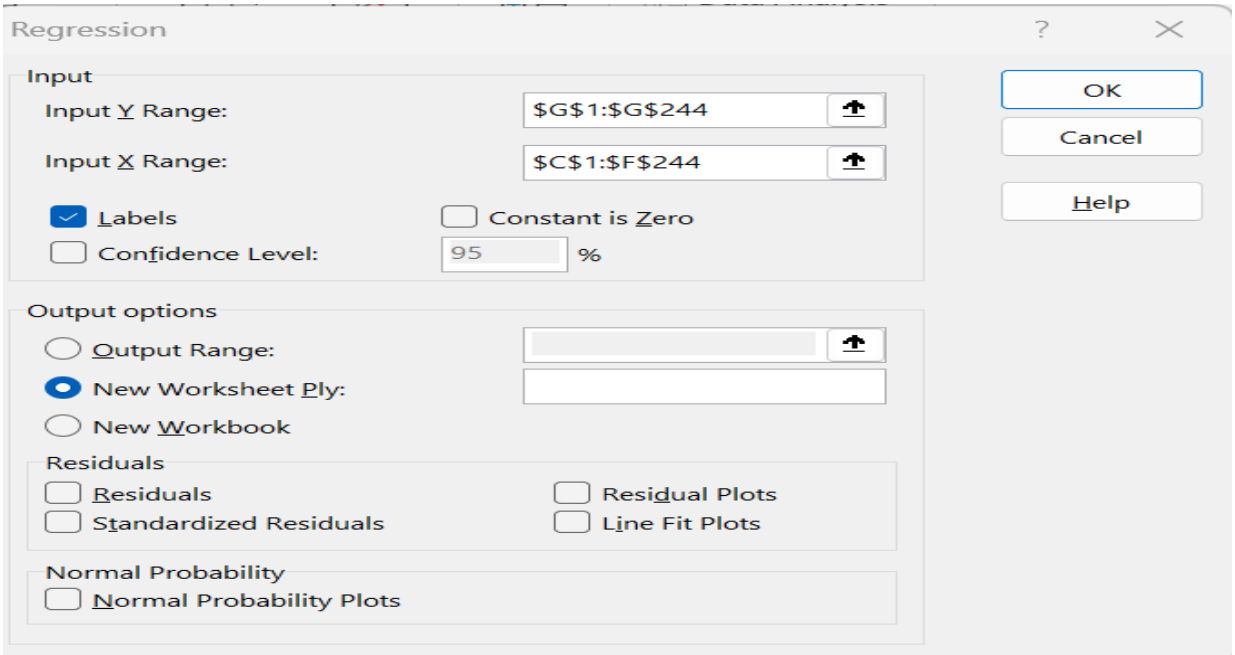
Key Observations:

- **Tip & Total Bill (0.67)**: This shows a strong positive correlation, meaning higher total bills generally result in higher tips.
- **Size & Total Bill (0.59)**: A moderate positive correlation, suggesting that larger groups tend to spend more.
- **Time & Total Bill (-0.17)**: A weak negative correlation, possibly indicating that meal timing affects spending habits.
- **Smoker & Tip (0.0097)**: Almost no correlation, meaning smoking status does not significantly impact tipping. (or have a nonlinear relationship with tip (Since correlation coefficient only checks for linear relationship. In case of other type of relationship, coefficient will either 0 or closer to 0) but that is beyond the scope of this project. So, we can exclude sex and smoker features from the Regression Model.)

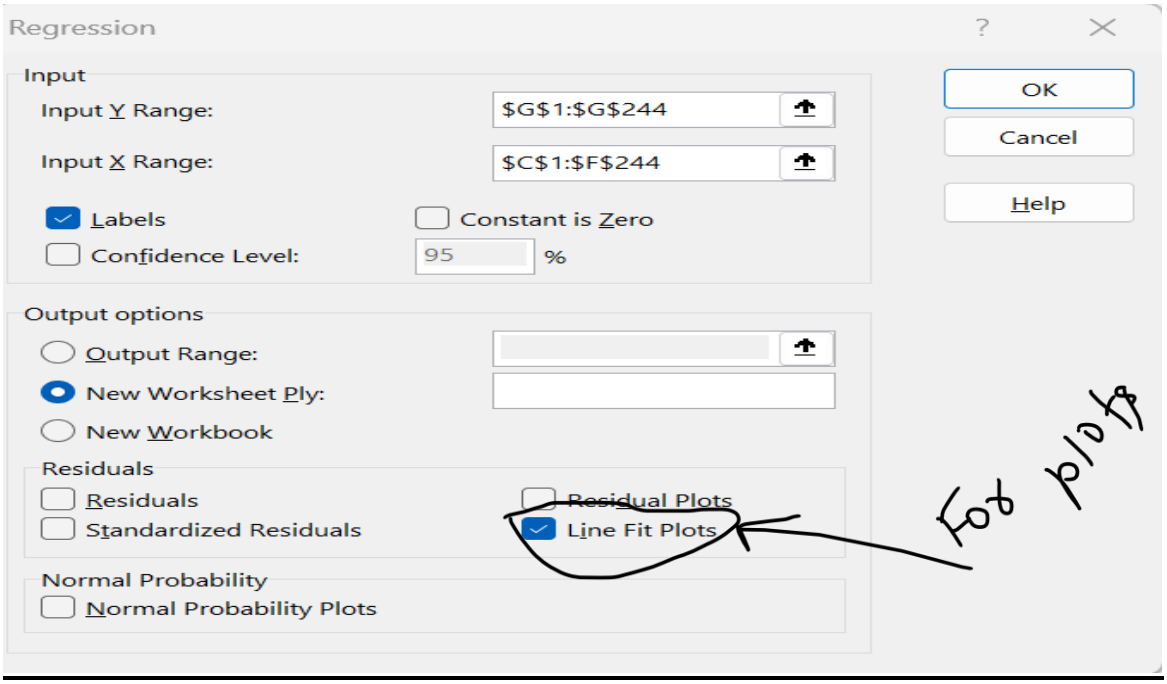
Model Building:

Using Excel's **Data Analysis Add-in**, we will build a **linear regression model** to predict the tip amount. Since multiple factors influence the tip amount, a multiple linear regression model will be used (Note: This is not the same as multivariate regression).

Now go to the **Data tab -> Data Analysis ->** click on **Regression. Input Y range** is the Select "tip cell" as the **dependent variable**. And **input X range** is Select the transformed/encoded **independent variables (time, day, size,total bill)** as input features.



For line fit plots:



Output and Model Evaluation Measures:

- **R-squared and p-values**

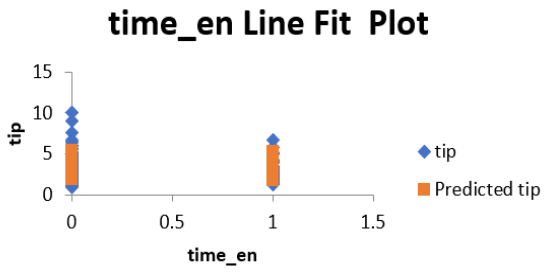
Regression Statistics	
Multiple R	0.683953829
R Square	0.46779284
Adjusted R Square	0.458848182
Standard Error	1.018849351
Observations	243

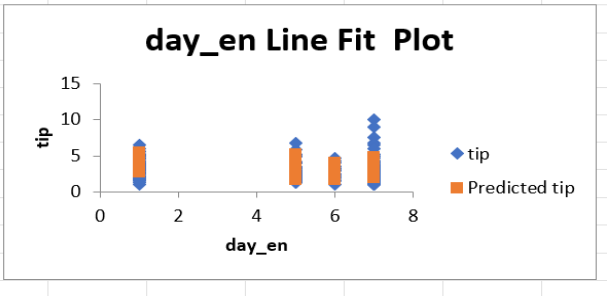
ANOVA

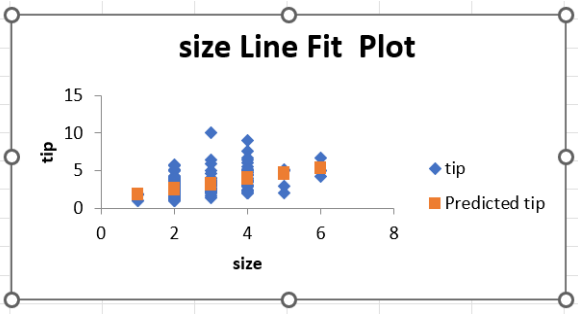
	df	*SS*	*MS*	*F*	*Significance F*
Regression	4	217.1549637	54.28874093	52.29857113	1.43528E-31
Residual	238	247.0568519	1.038054		
Total	242	464.2118156			

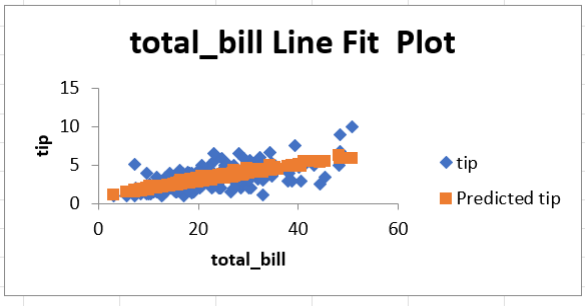
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.75984875	0.250420973	3.03428559	0.002678647	0.266524058	1.253173441	0.266524058	1.253173441
time_en	0.020254901	0.149929543	0.135096133	0.892650052	-0.275103529	0.315613331	-0.275103529	0.315613331
day_en	-0.01708897	0.02666475	-0.640882426	0.522215685	-0.069618036	0.035440096	-0.069618036	0.035440096
size	0.183369889	0.086899346	2.110141191	0.035890244	0.012179783	0.354559995	0.012179783	0.354559995
total_bill	0.09301373	0.009284134	10.0185678	6.13287E-20	0.074724157	0.111303303	0.074724157	0.111303303

Line Fit Plots: Predicted vs. Actual Tips

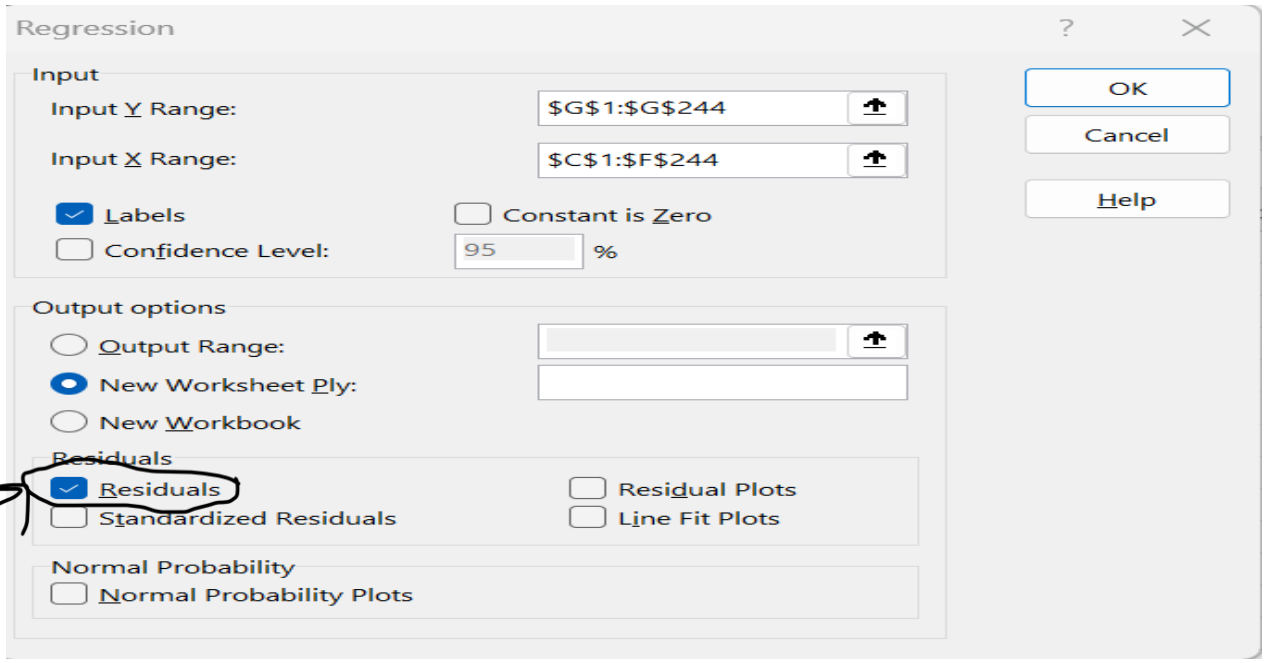








Residual:



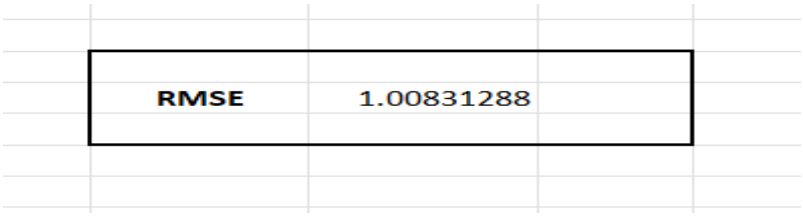
RESIDUAL OUTPUT:

RESIDUAL OUTPUT		
Observation	*Predicted tip*	*Residuals*
1	2.689802833	-1.679802833
2	2.254631417	-0.594631417
3	3.247087918	0.252912082
4	3.312064688	-0.002064688
5	3.763446961	-0.153446961
6	3.828556572	0.881443428
7	1.925229972	0.074770028
8	3.976448403	-0.856448403
9	2.50842606	-0.54842606
10	2.48424249	0.74575751
11	2.064750567	-0.354750567
12	4.755903461	0.244096539
13	2.543771277	-0.973771277
14	3.190482383	-0.190482383
15	2.488893176	0.531106824
16	3.116735855	0.803264145
17	2.25370128	-0.58370128
18	2.808063111	0.901936889
19	2.871312448	0.628687552
20	3.111069155	0.238930845

Calculate RMSE:

The **Root Mean Square Error (RMSE)** is calculated to evaluate the model's performance.

=SQRT(SUMSQ(C28:C270)/COUNTA(C28:C270))



CONCLUSIONS:

The model can predict restaurant tips with moderate accuracy. It has a Root Mean Square Error **(RMSE)** of 1.0083 and an R-squared value of 0.46, meaning it explains 46% of the variation in tips. However, only the **size** and **total_bill** variables are statistically significant, meaning they have a meaningful impact on predicting tips. The other variables do not show statistical significance and may not strongly influence tip predictions.