ASSIGNMENT -1 CUSTOMER ANALYTICS
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Q1.1

CODE OUTPUT: (Screenshot)

```
M:   34.405
p:   0.003
q:   0.214
N(30):   0.974
```

Q1.2

```
print('p: ', round(popt[0],5))
print('q: ', round(popt[1],5))
```

```
p:   0.00106
q:   0.19368
```

p: 0.00106
q: 0.19368

Q1.3

```
print('N(30): ', round(df2['N(t)'].loc[29],3))
```

```
N(30):   4.89
```

N(30): 4.89

Q1.4

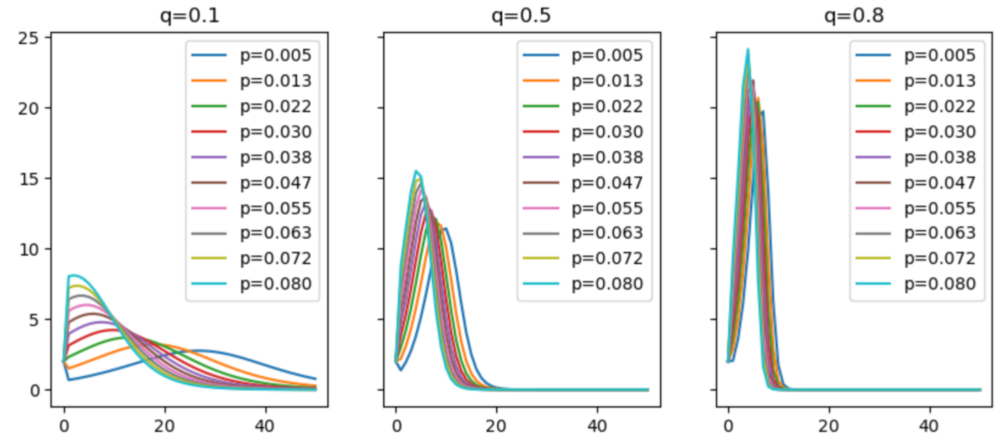
```
p:   0.000955
q:   0.17857
100
```

```
print('N(30): ', round(df3['N(t)'].loc[29],3))
```

```
N(30):   4.504
```

P: 0.000955
Q: 0.17857
M=100
N(30) = 4.504

Option Q2:



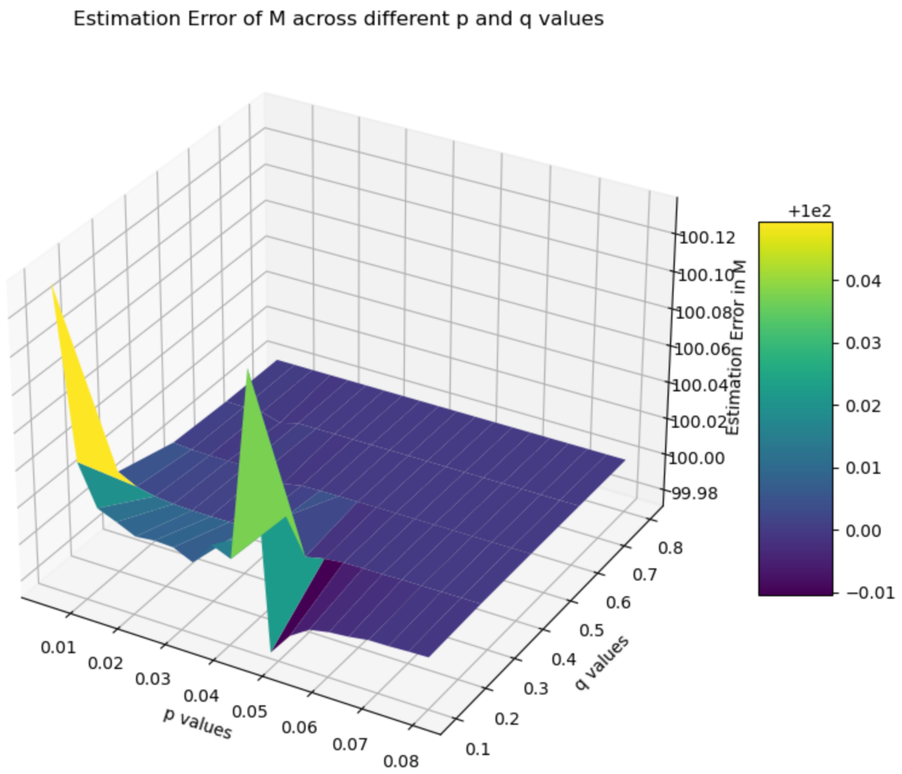
The shape of the adoption curve is influenced by both *p* (the coefficient of innovation) and *q* (the coefficient of imitation). When both *p* and *q* are low, near zero, the adoption curve tends to be more gradual, indicating a slower uptake of the product. As either *p* or *q* increases, the shape of the curve alters significantly. A higher *p* results in a steeper initial rise, indicating a faster uptake at the outset, and the peak adoption tends to occur earlier. On the other hand, a higher *q* leads to a more pronounced peak, with the curve rising and falling more sharply, suggesting a more rapid spread following the initial adoption.

The height of the adoption curve is positively correlated with both *p* and *q*. Higher values of *p* lead to a greater initial number of adopters, thereby increasing the curve's height, assuming *q* remains constant. Similarly, a higher *q* can also amplify the height of the curve, given that *p* remains unchanged. The interplay of high *p* and *q* values can result in a more pronounced and taller peak in adoption.

The slope of the adoption curve, representing the rate of increase in new adopters, is directly related to the values of *p* and *q*. As *p* or *q* increases, so does the slope, indicating a faster rate of adoption. The steepness of the slope reflects the combined effect of innovation and imitation on the diffusion of the product.

The decay phase of the curve, or how quickly the number of new adopters diminishes after the peak, is predominantly affected by the value of *q*. A higher *q* usually means a quicker decay, implying a swift drop-off in new adopters following the peak, which can indicate a rapid saturation of the market. Conversely, as *q* approaches zero, the decay phase lengthens, signifying a more sustained rate of adoption over a longer period.

Optional Q3:



1. Impact of *p* (Innovation): As *p* increases, the estimation error for *M* initially rises. This could imply that when the innovation effect is stronger, it is more challenging to accurately estimate the total market size based solely on early adoption data. Early adopters, influenced by *p*, are not necessarily indicative of the follow-on effect from imitators, which primarily drives market saturation.
2. Impact of *q* (Imitation): Variations in *q* seem to produce different trends. For lower values of *p*, changes in *q* create a more pronounced estimation error in *M*, suggesting that when initial adoption is less influenced by innovators, the imitation effect becomes more crucial to predicting the total market potential. However, as *p* increases, the impact of *q* on *M*'s estimation error seems to diminish, indicating that the initial adoption rate might overshadow the imitation effects in the early market estimation.
3. Combined Impact: The estimation error tends to be less when either *p* or *q* is at an intermediate level. This could indicate that a balance between innovation and imitation provides a more stable basis for estimating *M*. If either parameter is too high, it may cause overfitting to early trends, leading to inaccurate forecasts.

4. **Practical Implications:** this graph suggests that when using early adoption data to estimate market potential, caution should be exercised. Relying too heavily on the initial surge of adopters could lead to overestimates of *M*, while underestimating the importance of imitators might lead to conservative estimates. Market researchers and forecasters must consider both parameters and evaluate a range of scenarios to mitigate the risk of substantial forecasting errors.

Optional Q4

Use this equation as M is given, N, A(t) is given and can be calculated, now for doing linear regression and find p, q values:

$$\frac{N(t)}{R(t)} = p + q\frac{A(t)}{M}$$

Preform Linear Regression of above function gives you direct values of *p,q* from coefficient of B0 and B1.

```
Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.
Estimated values of p and q:
p: 0.00106323990344581
q: 0.19352467232294604
```

Values doesn't match with Q1.4 but still it give approximate match of Q1.4 values, *p= 0.0009, q = 0.178, p'= 0.0016 and q'=0.19*

Optional Q5

Question Q1: Bass Noise-Robust Estimation
Prompt A (For Estimating "M", "p", and "q" using linear regression):

- "How can I estimate the parameters of the Bass model using linear regression in Python?"

Prompt B (For Estimating "p" and "q" with fixed "M" using nonlinear regression):

- "Can you show me how to estimate 'p' and 'q' with a fixed 'M' using nonlinear regression in Python?" I provided a Python code snippet utilizing the curve_fit function to perform the estimation of "p" and "q" with a given fixed "M".

Prompt C (For Forecasting N(30) with estimated "p" and "q"):

- "Using estimated 'p' and 'q', how can I forecast future values of N(t) in the Bass model?"

Prompt D (For Continuous Bass Model estimation of "p" and "q"):

- "Guide me through using the Continuous Bass Model for estimating 'p' and 'q' in Python."

Question Q2: Influence of "p" and "q" on the Bass Model Curve
Prompt for Plotting Bass Model Curves:

- "I need to visualize how different 'p' and 'q' values affect the N(t) curve in the Bass model."
- I provided instructions on how to create plots in Python, showing the impact of different "p" and "q" values on the adoption curve.

Question Q3: Analysis of Estimation Error in "M"
Prompt for Analysis of Noise Impact:

- "Explain how noise in early adoption data can affect the estimation of the market potential 'M' in the Bass model."
- "Gave the graph code, now plot the 3-d data, notice any changes in that"

Question Q4: Conversion to Linear Regression
Prompt for Linearizing the Bass Model Equation:

- "Show how to convert the nonlinear Bass model into a linear regression form when 'M' is fixed using given equation, (gave the equation)"