

# Assignment -5

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## PART A:

	alpha	beta	tss	keyword
0	74.090862	0.039449	229.814751	kw8322228
1	156.439803	0.150083	383.573004	kw8322392
2	104.799293	0.079717	216.308754	kw8322393
3	188.111279	0.432292	565.69058	kw8322445

## PART B:

	keyword	ltv	conv.rate
0	kw8322228	354	0.30
1	kw8322392	181	0.32
2	kw8322393	283	0.30
3	kw8322445	107	0.30

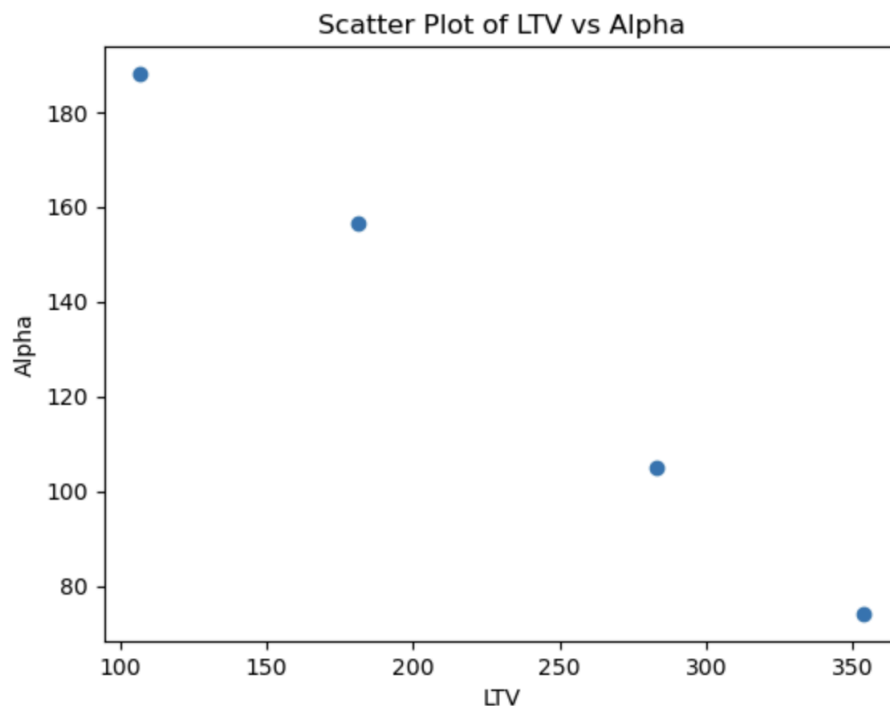
	b	profit	expenditure	keyword
0	34.127623	3950.456962	1870.615465	kw8322228
1	13.563448	6032.902219	1844.75465	kw8322392
2	22.433868	5451.614108	1957.873607	kw8322393
3	5.816956	4544.188925	1005.718622	kw8322445

## PART C:

	b	expenditure	profit	keyword
0	17.924261	673.208958	3315.507388	kw8322228
1	8.118451	894.506834	5487.232075	kw8322392
2	12.828288	860.885389	4836.614343	kw8322393
3	3.775700	571.398818	4286.482717	kw8322445

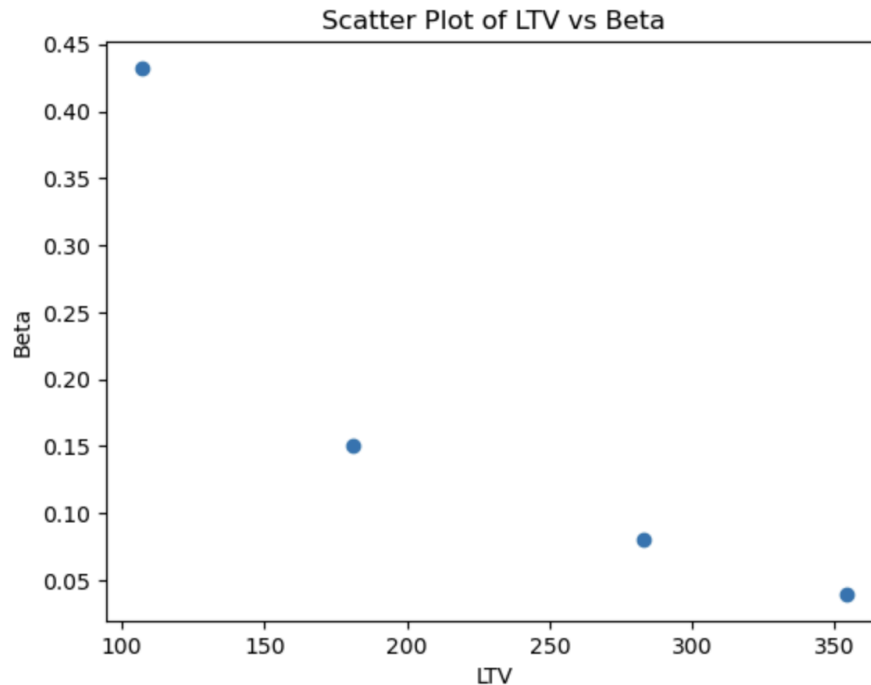
## PART D:

Alpha



### Relationship between LTV and Alpha

LTV tends to decrease with higher values of alpha. For example, the keyword kw8322228 has the highest LTV at 354, while its alpha value is 74, the lowest among the four keywords. One possible explanation for this relationship is that alpha is directly proportional to Click-Through Rate (CTR) and search volume. Higher alpha values indicate higher CTR and search volume, which might be more prevalent among customers looking for deals rather than brand loyalty. These ads, often placed in the middle positions, strike a balance between CTR and search volume. Customers converting through ads with higher alpha values might be deal-seekers who exhibit lower brand loyalty and consequently have a lower LTV.



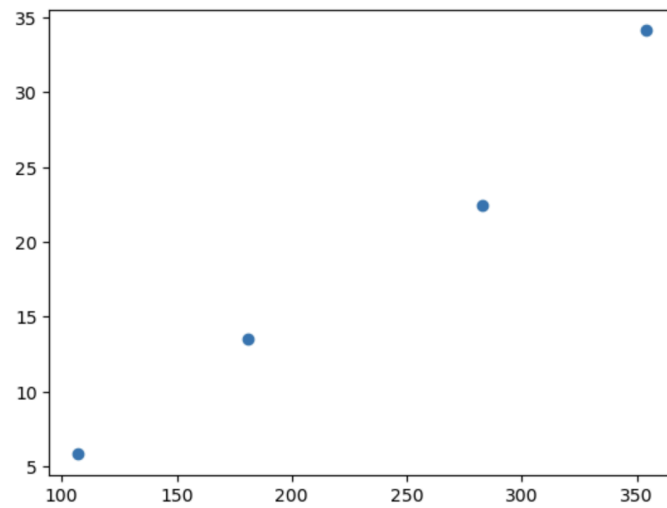
#### **Relationship between LTV and Beta**

LTV also tends to decrease with higher values of beta. For instance, kw8322228 has the highest LTV at 354, but its beta value is the lowest at 0.039. This relationship might be explained by the fact that beta is inversely proportional to competition intensity. Ads with higher beta values attract a broader audience but may not be as effective in converting clicks into long-term customer relationships. These customers may exhibit lower engagement or retention rates, leading to a lower LTV. Higher beta values indicate lower competition, which might mean that the audience is less targeted and includes a higher proportion of less loyal customers.

#### **Relationship between LTV and Optimal Bid:**

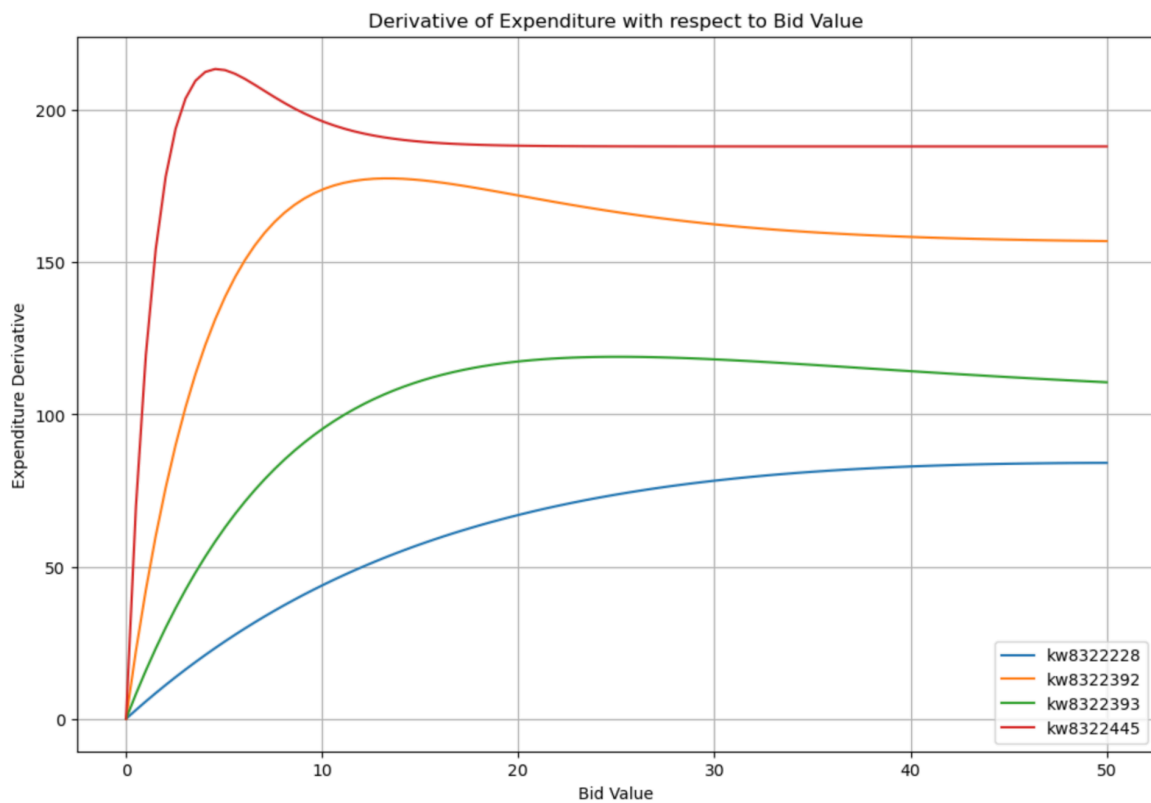
LTV tends to increase with higher values of the optimal bid. For instance, kw8322228 has the highest LTV at 354, and it also has the highest optimal bid value at 34.27. This relationship can be attributed to the fact that investing more in acquiring customers through higher bids allows for targeting more valuable segments or attracting customers who are more likely to generate higher revenue over their lifetime. Higher bids can lead to better ad placements, higher visibility, or reaching a more qualified audience, which can contribute to acquiring customers with higher LTV. Essentially, the higher investment in bids correlates with targeting more profitable and loyal customer segments.

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## PART E: (OPTIONAL)

### DERIVATIVE OF EXPENDITURE



Keyword least affected by the budget constraint: **kw8322445**

Percentage reduction in expenditure: **43.19%**

Reason: The low sensitivity of kw8322445 to changes in bid values, as seen in the derivative curve, indicates that its expenditure is less impacted by bid changes. This makes it less affected by budget constraints.

## **PART F: (OPTIONAL) GEN AI USAGE**

### Prompts and Outputs

Prompt 1:

Tool: ChatGPT

Prompt: "There are two parameters alpha and beta for four keywords using nonlinear regression. Provide the code to do this in Python using `scipy.optimize.curve_fit`."

Output: Provided code to estimate alpha and beta parameters using `curve_fit`, including data loading, model definition, and parameter estimation.

Prompt 2:

Tool: ChatGPT

Prompt: "Using the alpha and beta parameters, write a code to find optimal bid values that maximize profit without any budget constraint."

Output: Provided code to define the profit function and perform optimization using `scipy.optimize.minimize`, along with the results for optimal bids, profit, and expenditure. (code is flawed, I did the debugging)

Prompt 3:

Tool: ChatGPT

Prompt: Now I have budget of \$3000 budget constraint across four keywords. Provide the code to do this in Python using `scipy.optimize.minimize` with `NonlinearConstraint`.

Output: Provided code to set up and solve the constrained optimization problem using `scipy.optimize.minimize` with `NonlinearConstraint`, along with the results for optimal bids, profit, and expenditure. (Code is flawed, I did the debugging)