

CUMCM-2026 Problem E

SEM Advertising Placement Strategy

Since Search Engine Marketing (SEM) advertising has some characteristics, such as its instantaneity and the uncertainty of related factors, maximizing the overall benefits of advertising placement by rationally using of limited advertising funds is the issue that enterprises care most about in SEM advertising deployment. At present, under conditions such as continuously rising keyword bidding costs and fierce industry competition, the traditional model of solely relying on increasing the budgets to seize traffic is no longer sustainable, and there may even be a situation where the advertising costs invested are disproportionate to the benefits generated.

An Internet company launched SEM advertising for a certain product, designing 5 plans, 12 ad units, and over 6000 keywords. In 2025, the company invested approximately 1.42 million yuan in RMB, and achieved certain benefits. The company hopes to further improve the effectiveness of its advertising placement by optimizing keywords and the corresponding placement strategies. Please establish mathematical models to solve the following problems.

Problem 1 Based on the data for 2025 provided in Attachment 1, analyze the rationality of the company's SEM advertising placement strategy from the aspects of advertising design quality and creativity, keywords management and utilization, bidding strategy and budget, and placement strategy and timing. Meanwhile, analyze the patterns of change between advertising effectiveness and placement time, as well as holiday effects, etc.

Problem 2 Based on the situation in 2025, please classify the keywords according to their input costs and benefits:

- (1) Golden keywords: low cost, high effectiveness;
- (2) Key keywords: high cost, high effectiveness;
- (3) Potential keywords: low cost, low effectiveness;
- (4) Ineffective keywords: high cost, low effectiveness;
- (5) Useless keywords: no cost, no effectiveness.

Please provide the main results of the classification in the paper, and save the detailed results to the file result2.xlsx (the template file is provided in Attachment 2).

Problem 3 Based on Problems 1 and 2, according to the types and association relationships of keywords, select appropriate keywords and give the placement model for each ad unit and associated keywords under the conditions of ensuring low cost, high efficiency, and completion but without exceeding the budget funds. Provide the optimal placement strategy for each day of February 1-8, 2025 and August 1-8, 2025 (including the placement dates and input costs of each plan, ad unit, and the related keywords, etc.), and explain the superiority of the placement strategies. Please provide the main results in the paper, and save the detailed results to the file result3.xlsx (the template file is provided in Attachment 2).

Problem 4 The company plans to continue placing SEM advertising for this product in 2026, intending to adopt the same plans, ad units, and keywords as in 2025, with a budget not exceeding the funds input in 2025. Considering that the bidding price for each keyword changes daily, there is uncertainty in factors such as impression volume, ad position, number of clicks,

page views, and registration volume, all of which will affect the actual effectiveness of advertising placement. Please provide the optimal placement strategy for each day of September 11-17, 2026, and estimate the expected ranges of keyword bidding prices, impression volume, ad position, number of clicks, page views, and registration volume. Please present the main results in the paper, and save the detailed results to the file result4.xlsx (the template file is given in Attachment 2).

Appendix Description of the attachments

Attachment 1 Data on keyword delivery and effectiveness in 2025, including 3 sheets, the field descriptions are as follows:

Sheet1 delivery plans and consumption records in 2025

Field name	Description
Date	Date of record.
Plan ID	ID of SEM advertising placement plan.
Ad unit ID	ID of the specific unit that delivers the product advertisement, a collection of a group of related keywords.
Impressions	Number of times an advertisement is viewed by users.
Clicks	Number of times users click on advertisements.
Spend	Total cost of all keywords used in the plan/ad unit (unit: yuan).
Top-area impressions	Number of times the advertisement appeared in the top area above the search results on the first page (within the top three positions).
First-position impressions	Number of times the advertisement appeared in the first position of the search results.
Top-area clicks	Number of times users clicked advertisements located in the top area.
Top-area spend	Total spend of all advertisements located in the top area and clicked (unit: yuan).

Sheet2 Number of new registered users per day in 2025

Field name	Description
Date	Date of record.
New registrations	Number of new registered users per day through SEM advertising and other methods.

Sheet 3 Statistical data of keywords launched in 2025

Field name	Description
Serial No.	Record serial number.
Keyword	The specific keyword used in SEM advertising.
Plan ID	The same as above.
Ad unit ID	The same as above.
Spend	Total cost on keywords in advertising (unit: yuan).
Clicks	Number of times users click on keywords.
Page views	Total number of visits to the website page after clicking on the advertisement, which is used to measure how deeply users browsed the advertisement.
Bounce rate	$\text{Bounce rate} = \frac{\text{Number of visits where only one page was viewed}}{\text{Total number of visits}} \times 100\%$ The ratio indicating the percentage of users who leave after viewing only one page upon entering the website;, the higher the value, the lower the user stickiness.
Average access time	The average time of accessing an advertising websites, reflecting user's attention to the advertising content.

Attachment 2 Folder of template files for the results, including 3 files:

- result2.xlsx Template file for the results of Problem 2
- result3.xlsx Template file for the results of Problem 3
- result4.xlsx Template file for the results of Problem 4