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REVIEWER'S REPORT

Manuscript No.: IJAR-59668

Title: Sequential Optimization of Real-Time Revenue Using Adaptive Online Learning

Recommendation:

Accept as it is .....

Accept after minor revision.....

Accept after major revision ...✓.....

Do not accept (*Reasons below*) .....

Reviewer's ID: JPR- **098**

Rating	Excel.	Good	Fair	Poor
Originality		✓		
Techn. Quality			✓	
Clarity		✓		
Significance			✓	

Detailed Reviewer's Report

Decision: Accept after Major Revision

Major Revisions

1. Clarify the Experimental Dataset and Reward Generation: The manuscript states that the experiment uses 10,000 users and a reward matrix of dimensions 10,000 × 9, with binary outcomes for each strategy. However, the origin of the dataset, the process used to generate the rewards, and the basis for assigning conversion outcomes are not explained. The authors should provide complete details to establish the reliability and reproducibility of the experiment.

2. Resolve the Reward Feedback and Experimental Design: The manuscript should clarify whether each user is exposed to only one selected marketing strategy or whether outcomes for all nine strategies are available. In a standard bandit setting, the algorithm generally observes feedback only for the selected arm. If the complete reward matrix is available to the algorithm, the authors must explain how this is handled without introducing information leakage or unrealistic feedback assumptions.

3. Explain the Selection and Configuration of the Nine Marketing Strategies: The nine strategies are described using generic labels such as Formula 1, Package 1, Advertisement 1, and Special Offer 1. Their actual configurations and differences are not sufficiently specified. The authors should provide

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meaningful descriptions of the strategies and explain how they were designed and selected for the experiment.

4. Improve the Mathematical Formulation and Assumptions: The paper assumes fixed but unknown conversion probabilities for the nine strategies. However, the discussion refers to adaptation to non-stationary environments and abrupt changes. The authors should clarify whether the proposed framework addresses a stationary or non-stationary bandit problem and ensure that the mathematical formulation, experimental setup, and conclusions are consistent.

5. Clarify the Role of Deep Q-Learning: An algorithm titled "Deep Q-Learning" is included in the manuscript, although the proposed methodology is based on Thompson Sampling. Its purpose, relationship to the proposed framework, and role in the experimental evaluation are unclear. The authors should either integrate and evaluate it appropriately or remove it if it is not part of the proposed study.

6. Strengthen the Statistical Evaluation: The manuscript reports 100 independent simulations and describes confidence intervals and a paired t-test. However, the corresponding numerical confidence intervals, standard deviations, p-values, and statistical test outcomes are not adequately presented. These results should be reported to support the claimed superiority of Thompson Sampling.

7. Reconcile the Experimental Results and Tables: The numerical results require careful verification and consistent presentation. Table 1 reports rewards of 968.0 for Random and 1513.0 for UCB, whereas Table 2 reports a Thompson Sampling reward of 1905.0 and a relative return of 96.80%. The authors should provide a complete Table 1, verify all reported values, and explain how the results were calculated across the 100 simulations.

8. Define the Detection-Time Metric: The manuscript reports detection times of 1212 iterations for Thompson Sampling and 6984 iterations for UCB. However, the criterion used to identify the optimal strategy is not clearly defined. The authors should specify the detection criterion, calculation procedure, and whether the reported values represent averages across the independent simulation runs.

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9. Provide a More Realistic Economic Analysis: The estimated additional revenue of USD 2 billion is based on 100 million users, a 20% conversion rate, and a USD 100 annual subscription price. This estimate appears to be a hypothetical projection rather than a result directly established by the 10,000-user simulation. The authors should clearly distinguish simulated results from projected revenue and consider relevant factors such as marketing costs, subscription retention, and actual conversion behaviour.

10. Strengthen the Discussion and Practical Validation: The discussion primarily restates the reported performance ranking of Random, UCB, and Thompson Sampling. The authors should provide deeper analysis of the results, discuss the limitations of the simulated environment, and explain how the proposed approach could be validated in a real e-commerce platform. Claims concerning advertising fatigue, deployment costs, and preservation of user experience should also be supported by the methodology or appropriately qualified.

Minor Revisions

1. Improve the Abstract: The abstract should clearly distinguish the proposed methodology, simulation setup, principal numerical findings, and practical implications. The projected USD 2 billion revenue should be identified as a hypothetical estimate rather than a directly measured experimental result.

2. Improve the Research Motivation: The introduction should establish the specific research gap more clearly and explain why Thompson Sampling is selected over other online learning approaches for the considered revenue optimization problem.

3. Clarify the Terminology: The terms online learning, reinforcement learning, multi-armed bandit, and contextual bandit should be used consistently. The authors should also clarify whether the proposed approach is a non-contextual or contextual bandit model.

4. Correct the Repetition in the Methodology: The Thompson Sampling procedure is described in both Sections II-B and II-C. The authors should reduce unnecessary repetition and clearly distinguish the mathematical formulation from its implementation.

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5. Improve Algorithm Presentation: The pseudocode should follow a consistent format, with proper indentation, variable definitions, input/output descriptions, and clearly numbered steps. The relevance of the Deep Q-Learning algorithm should also be clarified.

6. Improve Figure Quality and Captions: All figures should have clear labels, readable legends, appropriate axis titles, and consistent numbering. The relationship between Figure 1, Figure 2, and the corresponding experimental results should be clearly explained.

7. Improve Table Formatting: Tables 1 and 2 should be formatted consistently, with complete entries, clearly defined metrics, and appropriate units. The meaning of cumulative reward, regret, relative return, and detection time should be explained.

8. Correct Mathematical Notation: Mathematical equations should be checked for formatting, indexing, symbols, and consistency. All variables, including K, T, theta_k, alpha_k, and beta_k, should be defined before or immediately after their first use.

9. Improve Language and Grammar: The manuscript requires careful proofreading to correct grammatical errors, missing spaces, inconsistent punctuation, and awkward sentence construction. For example, the phrase "The observed reward" is repeated in the implementation section.

10. Check References and Journal Formatting: The authors should verify the accuracy and completeness of all references, ensure that every citation corresponds to the relevant discussion, and follow the journal's prescribed referencing and formatting style.