



Project Report



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Team Name

Night Owls

Program

**BS in Data Science
& Application**

1. Problem Statement

This study aims to analyze the impact of advertisement frequency on consumer purchase behavior by examining how repeated ad exposures influence engagement metrics such as click-through rates (CTR), conversion rates, and purchase likelihood. Specifically, the goal is to determine the optimal number of ad exposures that maximize conversions without causing ad fatigue, using real-world online advertising data.

Objective

The goal of this study is to:

- Identify the relationship between advertisement exposure frequency and consumer engagement.
- Determine the optimal number of ad exposures before engagement stagnates or decreases.
- Assess the effectiveness of different advertising channels and campaign types.
- Evaluate the role of ad spend in influencing conversion rates.
- Provide actionable recommendations for ad budget allocation and audience targeting.

Motivation

With increasing digital advertising costs, businesses need to optimize ad spending to maximize conversions without wasting budget on excessive exposure. Understanding the **ideal number of ad exposures** and **how different factors (e.g., ad spend, campaign type, and viewer behavior) influence engagement** can significantly enhance marketing efficiency. This study helps marketers allocate budgets effectively by focusing on first-time engagement and avoiding diminishing returns from excessive retargeting.

2. Dataset

The dataset consists of records from various digital marketing campaigns, capturing the following key attributes:

- **Campaign Details:** Campaign type (Awareness, Retention, Conversion, Consideration), Advertising platform, Advertising tool.
- **Ad Spend & Exposure:** Ad spend, Campaign channel (PPC, Social Media, Email, SEO, Referral), Estimated ad exposures.
- **Engagement Metrics:** Click-through rate (CTR), Conversion rate, Website visits, Pages per visit, Time on site, Social shares.
- **User Demographics:** Customer ID, Age, Gender, Income.
- **User Behavior:** Email opens, Email clicks, Previous purchases, Loyalty points.

Constraints & Solutions

- **No Direct Ad Exposure Count in Dataset:**

- **Solution:** Created a derived metric for **Estimated Ad Exposures** using the sum of WebsiteVisits, EmailOpens, EmailClicks, and SocialShares.
- **No Direct Timeframe for Exposure Frequency:**
 - **Solution:** Grouped ad exposures into **Short-Term (1-3 Days)**, **Medium-Term (1-2 Weeks)**, and **Long-Term (3+ Weeks)** based on engagement activity.
- **Determining First-Time vs. Repeated Viewers:**
 - **Solution:** Defined **First-Time Viewers** as those in the lowest 10% exposure percentile and **Repeated Viewers** as those above the threshold.
- **Ad Fatigue Detection:**
 - **Solution:** Used regression analysis on CTR and Conversion Rate over increasing exposures to identify stagnation and declining engagement.

3. Approach

To systematically analyze the impact of ad exposure on consumer behavior, we followed a structured approach:

1. **Data Preprocessing & Cleaning:**
 - Removed inconsistencies and missing values.
 - Standardized campaign types and advertising channels.
2. **Feature Engineering & Metric Creation:**
 - Computed **Estimated Ad Exposures** using user interaction metrics.
 - Defined **Viewer Type** based on percentile segmentation (First-Time vs. Repeated).
 - Grouped **Ad Exposure Duration** to analyze short, medium, and long-term effects.
3. **Exploratory Data Analysis (EDA):**
 - Used **Pivot Tables & Charts** to visualize CTR, Conversion Rate, and engagement trends.
 - Analyzed **Campaign Type, Channel, and Ad Spend** performance.
4. **Trend Analysis:**
 - Detected **ad fatigue** by plotting CTR & Conversion Rate over increasing exposures.
5. **Business Insights & Recommendations:**
 - Determined the **best ad exposure frequency** for maximum conversions.
 - Suggested **optimal budget allocation strategies** based on ad performance trends.

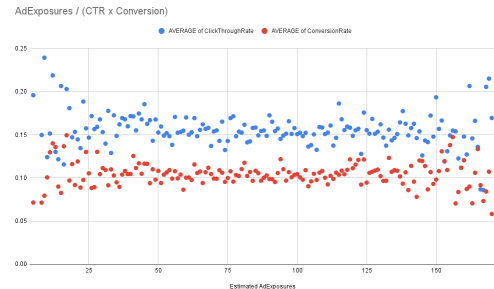
Decision Variables

- **Ad Exposure Count:** Number of times a user sees an ad (estimated based on engagement metrics).
- **Ad Exposure Duration:** Short-Term (1-3 Days), Medium-Term (1-2 Weeks), Long-Term (3+ Weeks).
- **CTR & Conversion Rate:** Used as key performance indicators to measure engagement effectiveness.

- **Campaign Type & Channel:** Analyzed different campaign strategies (Awareness, Retention, etc.) and channels (PPC, Social Media, etc.).
- **Ad Spend:** Examined different budget levels (\$0-1K, \$1K-5K, \$5K-10K) to find the most efficient range.

4. Results, Findings & Recommendations

- **Campaign Performance:**
 - Consideration campaigns had the **highest conversion rate**.
 - Retention campaigns had the **highest click-through rate (CTR)**.
- **Channel Performance:**
 - PPC campaigns had the **highest CTR**.
 - Social Media campaigns had the **highest conversion rate**.
- **Ad Spend Performance:**
 - The **\$1K - \$5K** ad spend range was the most efficient, yielding the **highest CTR & Conversion Rate**.
- **Optimal Ad Exposure:**
 - **1-20 Ad Exposures** resulted in the **highest CTR & Conversion Rate**.
 - **100+ exposures** led to **ad fatigue**, causing stagnation in engagement.
- **Viewer Type Analysis:**
 - **First-Time Viewers** had **higher CTR & Conversion Rates** compared to Repeated Viewers.
 - **Retargeting efforts** did not significantly improve conversion rates.
- **Ad Exposure Duration Analysis:**
 - **1-2 Weeks** exposure duration had the **highest CTR & Conversion Rate**.
 - **Short-term exposure (1-3 Days)** performed poorly, leading to lower conversions.
 - **Long-term exposure (3+ Weeks)** had diminishing returns.



Conclusion & Recommendations

- **Optimal ad exposure count:** **5-20 exposures within 1-2 weeks** is ideal for maximizing engagement and conversions.
- **Avoid excessive retargeting:** First-time viewers perform better than repeated viewers.
- **Budget allocation:** The **\$1K-\$5K ad spend range** is the most efficient for driving conversions.
- **Reduce short-term ad bursts (1-3 days):** These campaigns underperform in conversion rates.
- **Do not exceed 100+ exposures per user:** Ad fatigue leads to declining engagement and wasted budget.



Project By
Team Night Owls

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~ Dev, Satish, Prem, Srithi & Chaitanya

