

Predictive Analytics for Marketing Optimization

**Ad Campaign (Sales Creative) vs
PSA (Public Service Announcements)**

**BUAN 6337.001 - Predictive Analytics for
Data Science - F25 Professor: Mr. Joonhwi Joo**

Dataset - Marketing A/B Testing (kaggle)

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Business Context & Problem Statement

A digital platform shows two types of messages in the same ad space:

- Ad: Sales-driven content encouraging action.
- PSA: Neutral, awareness-based content with no sales push.

Business Problem:

The company must decide whether to fill this slot with Ad content or PSA content to maximize user conversions (purchases/sign-ups).

Problem Statement:

Which campaign type (Ad vs PSA) should we prioritize in this placement to maximize conversion rates, and by how much does that choice impact expected conversions?



Ad vs PSA

► Ad Campaign (Campaign A)

- Sales-focused content designed to drive clicks or purchases.
- Includes promotions, discounts, and call-to-action messages.
- Example: “Limited time – 20% off! Shop now!”

🌐 PSA Campaign (Campaign B)

- Public Service Announcement with neutral, awareness-based content (no sales push).
- Builds brand goodwill and user trust.
- Example: “Don’t text and drive.”

Research Questions

- Does the Ad campaign generate a higher conversion rate than the PSA campaign?
- If yes, how large is the difference in conversion rates (Average Treatment Effect)?
- Can we predict which users are more likely to convert based on their ad exposure (total ads, day, hour, campaign type)?

DATA SOURCE & STRUCTURE

Data Source: Kaggle – Marketing A/B Testing
n = 588,101 users (1 row per user)

Key Variables:

test.group – Ad vs PSA

converted – TRUE if purchased

total.ad – impressions seen

most.ads.day – peak weekday

most.ads.hour – peak hour (0-23)

user.id – unique

Design: Cross-sectional A/B experiment

user.id	test.group	converted	total.ads	most.ads.day	most.ads.hour
1069124	ad	FALSE	130	Monday	20
1111729	ad	FALSE	23	Tuesday	13
1101344	psa	TRUE	45	Friday	15

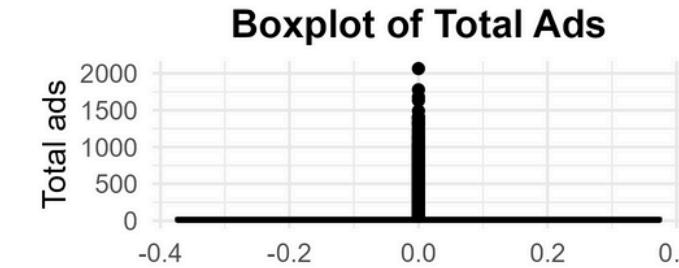
DATA PREPARATION

Marketing A/B Test – Pre-Cleaning & Visualisation

Distribution of Total Ads (log-scale)



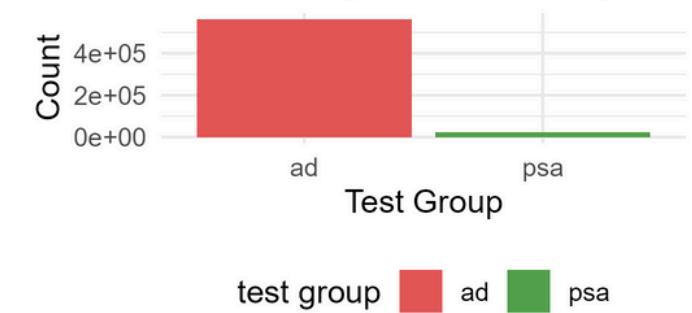
Boxplot of Total Ads



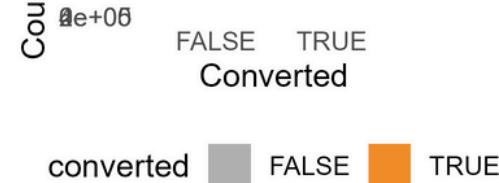
Most Ads by Hour of Day



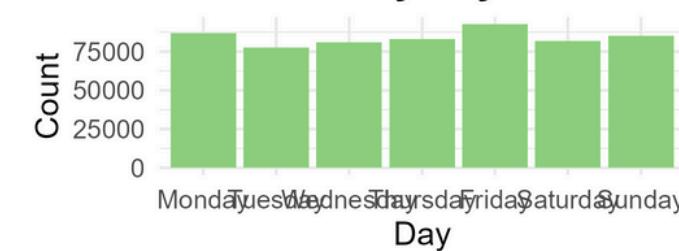
Users per Test Group



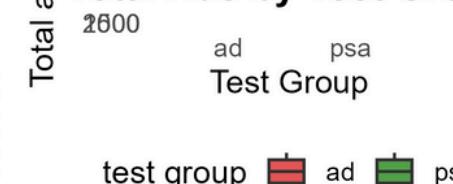
Conversion Count



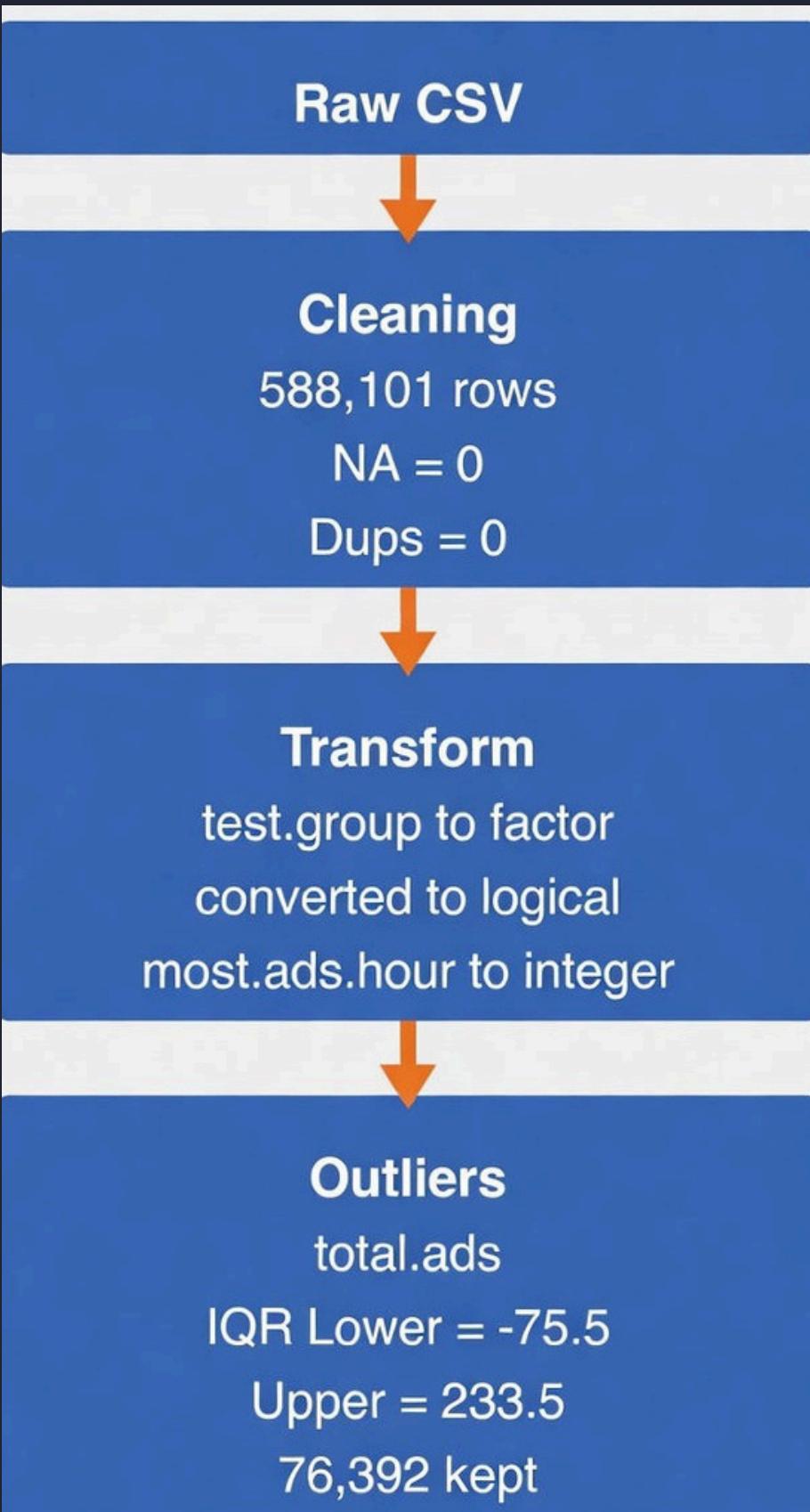
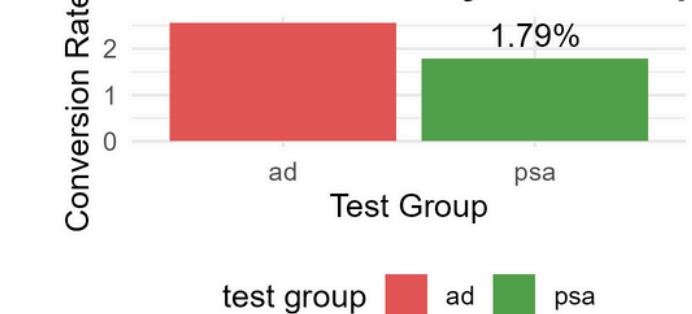
Most Ads by Day of Week



Total Ads by Test Group



Conversion Rate by Test Group



started with the raw CSV → removed the unnamed index column → and ended with a clean, analysis-ready data

Handled outliers in total.ads using the IQR rule.

Lower bound: negative 75.5 irrelevant.

Upper bound: 233.5. We found 76,392 users above this, the heavy ad viewers.

This clean, realistic dataset is now ready for A/B testing and predictive modeling.

HYPOTHESES FOR THE A/B

Null Hypothesis (H_0)

Conversion rate Ad = PSA

Alternative Hypothesis (H_1)

Conversion rate Ad \neq PSA

business logic; chi-square test used ($p < 0.001 \rightarrow$ reject H_0)

$\rightarrow H_0$ (Equal rates)

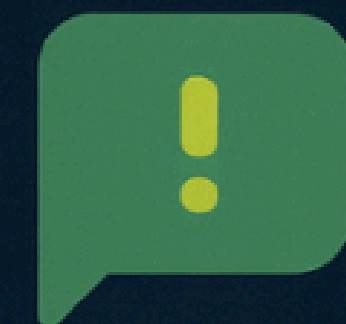
$\rightarrow H_1$ (Not equal rates.

Implying one is better
than other)

Group	Users	Total %	Conversion Rate
Ad	564,577	96%	2.55%
PSA	23,524	4%	1.79%



Descriptive Conversion Rates by Campaign



Campaign A (Ad)

Conversion Rate

2.55%

14,423 conversions
/ 564,577 users

Campaign B (PSA)

Conversion Rate

1.79%

420 conversions
/ 23,524 users

Interpretation:

Users shown Ad creatives convert significantly more than those shown PSA versions.

PSAs underperform for immediate conversions.

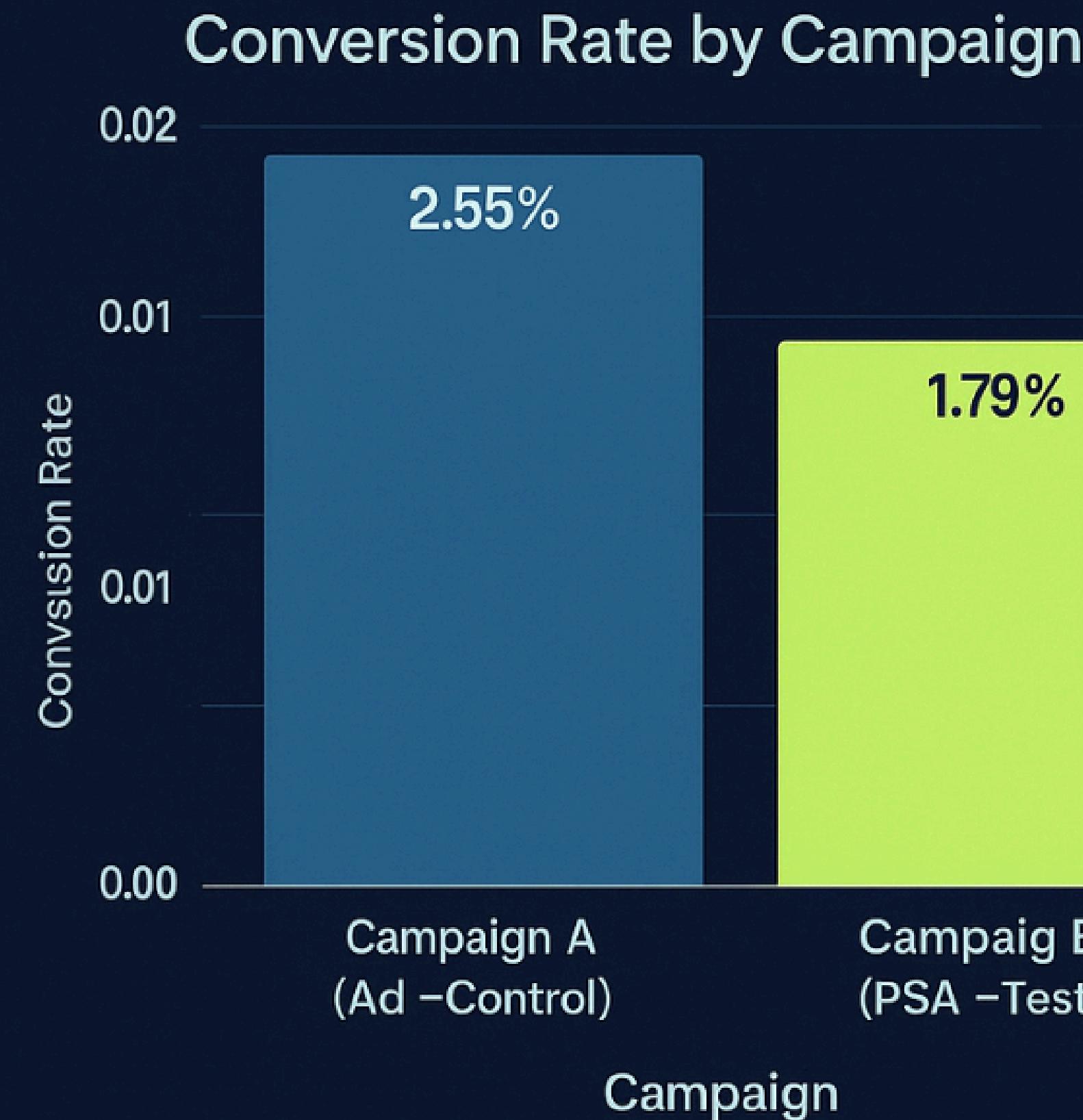
Conversion Rate Comparison: Ad vs PSA



Ad campaign
conversion
rate: 2.5%

PSA
campaign
conversion
rate: 1.79%

Ad's conversion
rate is roughly
42% higher
than PSA (2.55%
vs 1.79%)



Hypothesis Test: Chi-Square for Conversion Rates



Contingency Table (Counts)

	Converted	Not Converted
Ad	14.423	550.154
PSA	420	23.104

Decision

- Since $p < 0.05$, we reject H_0 .
- Conversion rates are significantly different between Ad and PSA



Chi-Square Test Results

$$\chi^2 = 54.0$$

$p\text{-value} < 0.001$

Decision

- Since $p < 0.05$, we reject H_0 .
- Conversion rates are significantly different between Ad and PSA

Interpretation

- The Ad campaign's conversion rate is 2.55%, while PSA's is 1.79%. This statistically significant gap means the Ad campaign is clearly

Average Treatment Effect (ATE) of PSA vs Ad

ATE =
Conversion rate (PSA)
– Conversion rate (Ad)

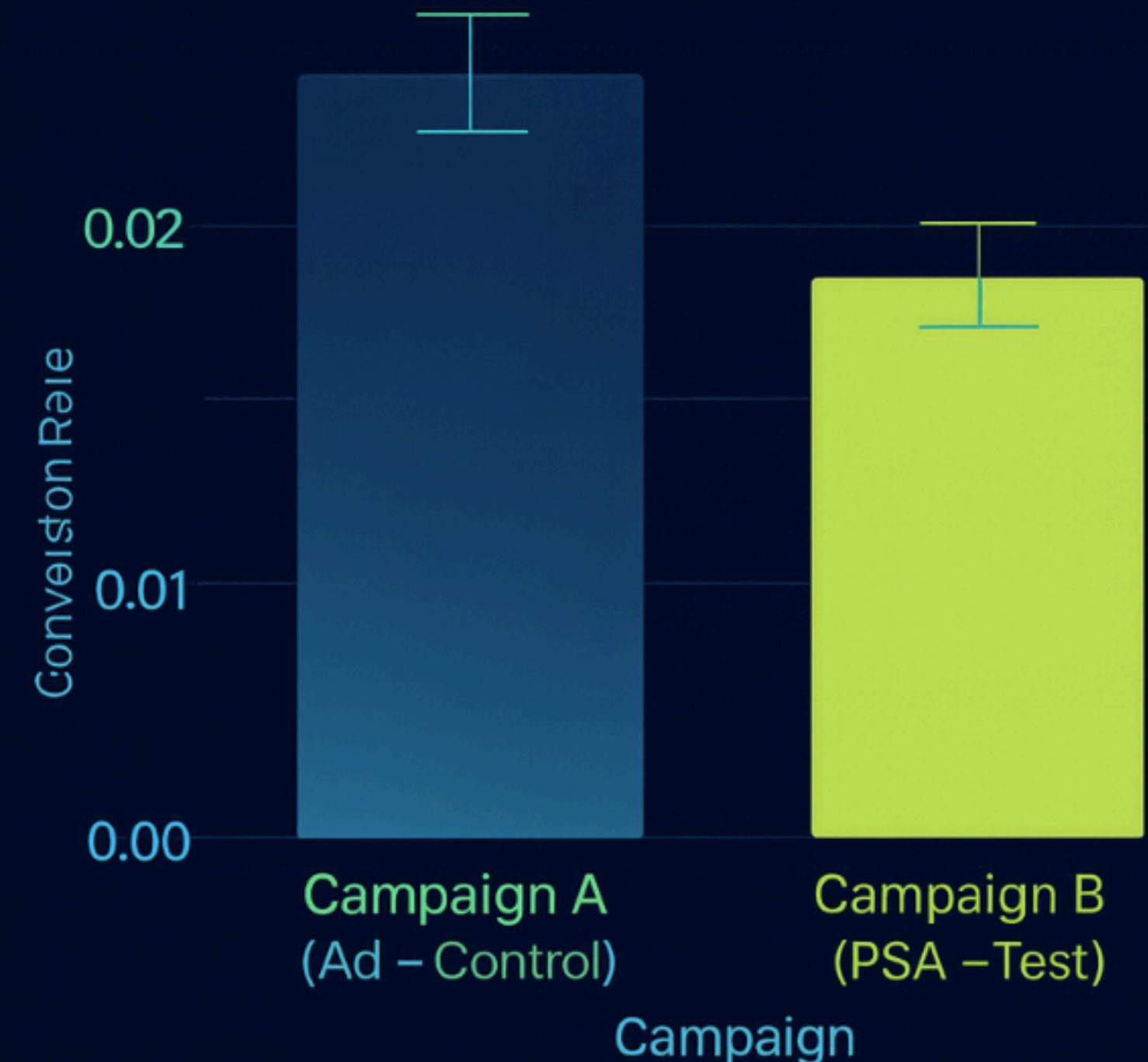
Estimated ATE ≈
–0.0077
(-0.77 percentage
points)

95% confidence
interval (-0.0094 to
–0.0060) does not
cross 0.

Business interpretation:

Replacing an Ad with a PSA in this slot reduces the conversion rate by about 0.77 percentage points. For the 23,524 users in the PSA group, using Ads instead could have resulted in ~179 additional conversions.

Conversion Rate comparison with 95% Confidence Interval



Logistic Regression Model

Outcome: converted (Yes/No)

Predictors:

test.group (Campaign A vs Campaign B)

total.ads (number of ads seen)



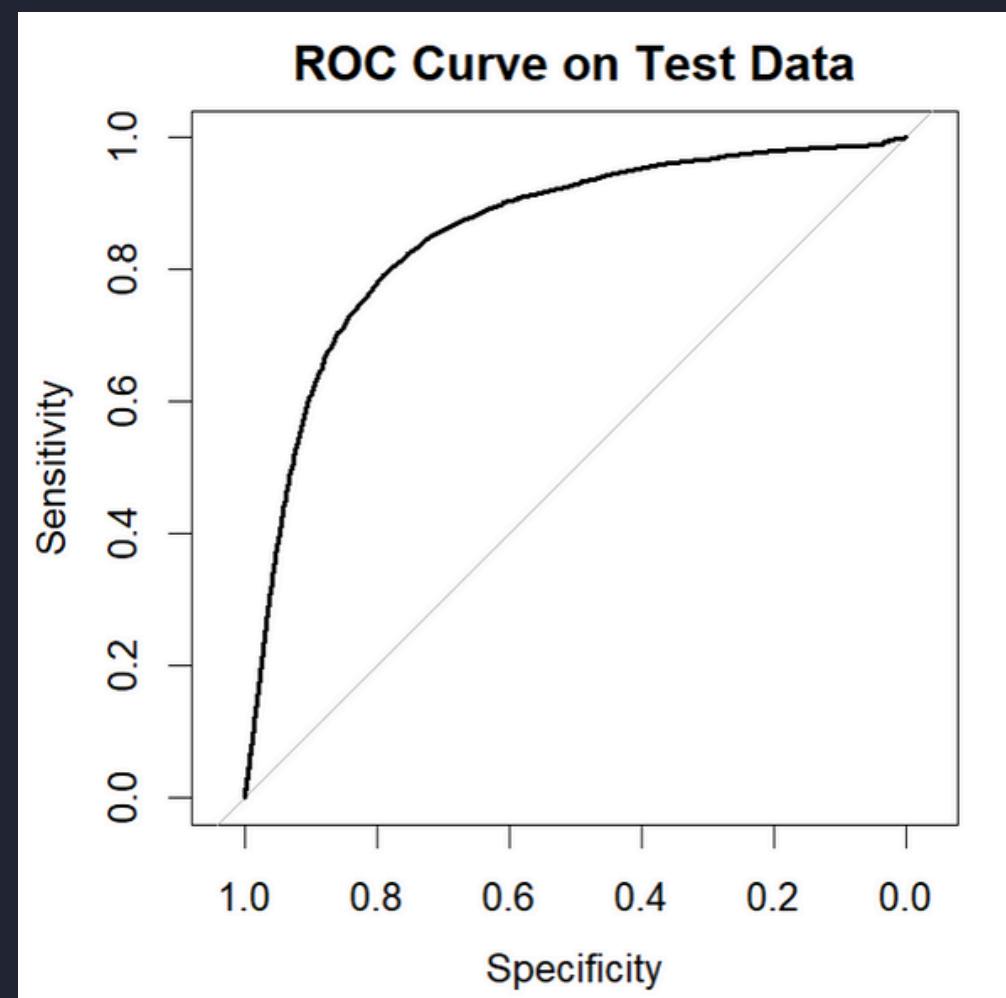
Key Results (Odds Ratios):

Variable	Odds Ratio	Interpretation
PSA vs Ad (test.group Campaign B)	0.67	PSA users have ~33% lower odds of converting
total ads (per additional ad)	1.01	Each extra ad increases odds by ~1%

Model Validation & Predicted Probabilities

Model Validation - ROC Curve:

Test - set AUC = 0.854

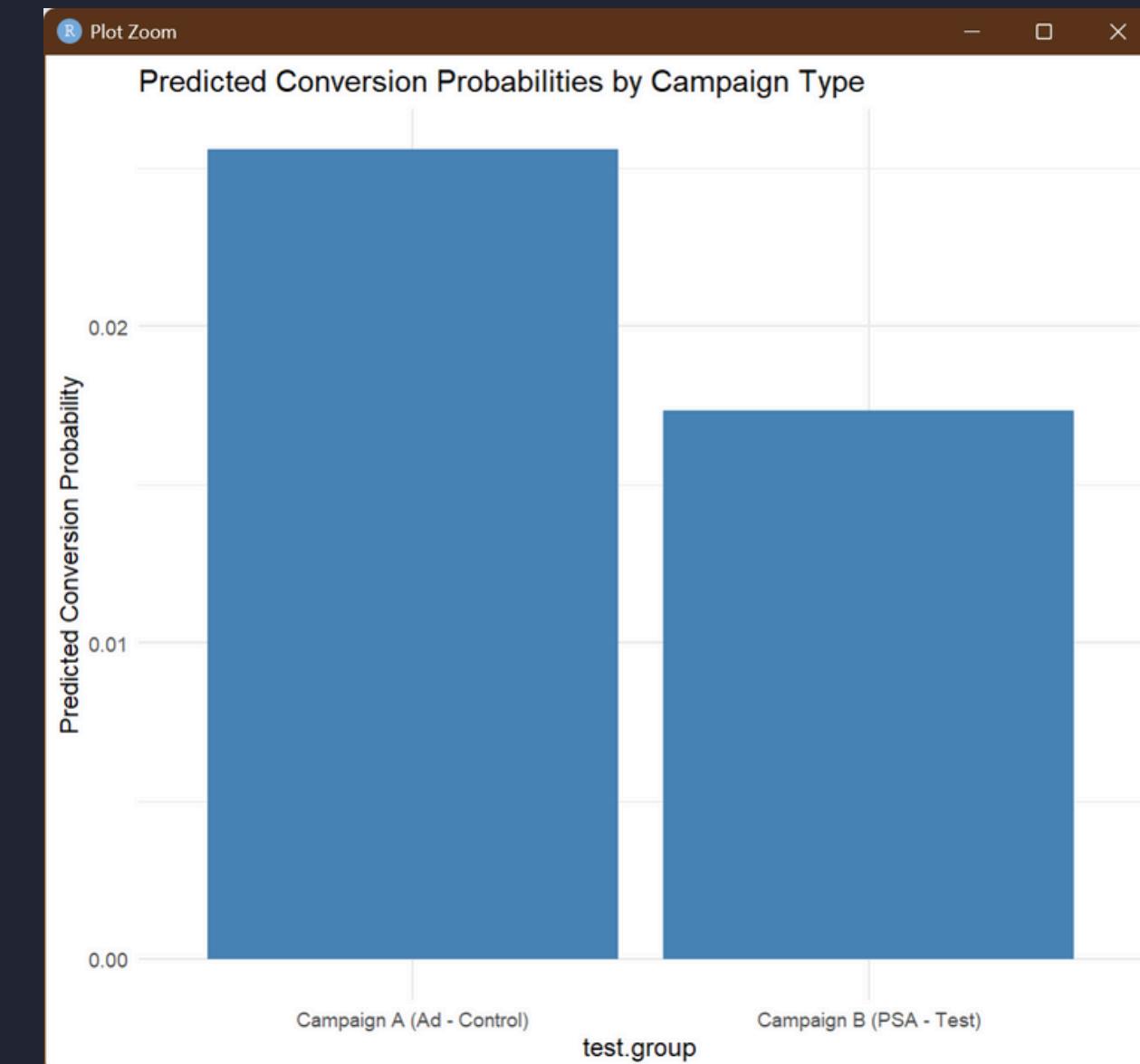


Indicates strong discrimination
between converted and non-converters.

Average Predicted Conversion Probabilities:

Ad Users: ~2.5%

PSA Users: ~1.7%



Business Implications



1. Performance Gap:

Ads convert 2.55%, PSA 1.79% → PSA causes ~0.77% loss in conversions.

2. PSA is Costly for Sales:

Lower odds of conversion ($OR = 0.67$), leading to lost revenue at scale.

3. Predictive Model Enables Targeting:

AUC of 0.854 means marketers can prioritize high-probability converters, improving ROI.

4. Randomization Check Passed:

Mean Total Ads similar across campaigns ($t\text{-test } p=0.827$), confirming experiment balanced

Conclusion & Recommendations

Conclusions:

- The ad campaign statistically and practically outperforms the PSA.
- PSA reduces conversions by ~0.77% points due to Average Treatment Effect.
- The logistic model confirms that campaign type & ad exposure drive conversion.

Recommendations:

- Utilize ad campaigns where sales/conversions are crucial.
- Avoid PSA placements where revenue is critical.
- Use the predictive model to score users & allocate budget efficiently.

Thank You!

Any Questions?

