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How Social Media Ads Use Math

RESEARCH PROJECT FOR THE RESEARCH FAIR

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ABSTRACT

This research project looks into how mathematical principles shape the functioning and effectiveness of social media advertising. The central problem guiding this study is understanding how digital platforms such as Instagram, TikTok, Facebook, and YouTube use mathematical models to determine who sees an ad, how ads are priced, and how success is measured. The main objective is to explain the key mathematical processes involved in modern online advertising, including visibility metrics, performance calculations, auction-based ad delivery, consumer targeting, and attribution models.

The methodology used is a descriptive analysis based on secondary research from industry guidelines, platform documentation, and digital advertising sources. The study reviews how platforms calculate visibility through metrics such as viewability standards, including minimum on-screen duration for ads. It also analyzes core formulas such as click-through rate and cost per result, which help advertisers evaluate performance and make budget decisions. Furthermore, the research explores auction-based allocation systems in which platforms compute relevance, bid value, and ad quality to determine which ad appears on a user's screen. Additional attention is given to attribution methods and lift tests, which help identify whether an ad truly influenced user behavior.

The main findings indicate that mathematics is essential to organizing ad delivery fairly and efficiently. It ensures ads reach the right users, reduces wasted spending, and improves future advertising decisions by transforming user actions into measurable data. Overall, the study concludes that math is the invisible structure that enables targeted, effective, and optimized advertising across digital platforms.

RESUMEN

Este proyecto de investigación analiza cómo los principios matemáticos influyen en el funcionamiento y la efectividad de la publicidad en redes sociales. El problema central del estudio es comprender cómo plataformas como Instagram, TikTok, Facebook y YouTube utilizan modelos matemáticos para decidir quién ve un anuncio, cómo se determina su costo y cómo se mide su éxito. El objetivo principal es explicar los procesos matemáticos que hacen posible la publicidad digital moderna, incluyendo métricas de visibilidad, cálculos de rendimiento, subastas de anuncios, segmentación y modelos de atribución.

La metodología utilizada es un análisis descriptivo basado en investigación secundaria proveniente de guías industriales, documentación de plataformas y fuentes especializadas en publicidad digital. El estudio revisa cómo las plataformas calculan la visibilidad mediante estándares de "viewability", que establecen el tiempo mínimo que un anuncio debe permanecer en pantalla. También analiza fórmulas fundamentales como la tasa de clics y el costo por resultado, que ayudan a los anunciantes a evaluar el desempeño de una campaña. Además, se examina el sistema de subastas mediante el cual las plataformas combinan relevancia, valor de puja y calidad del anuncio para decidir cuál aparece en la pantalla del usuario. El estudio también explica el uso de pruebas de "lift" y modelos de atribución que determinan si un anuncio realmente influyó en el comportamiento del usuario.

Los principales hallazgos demuestran que las matemáticas son esenciales para organizar y optimizar la entrega de anuncios. Permiten dirigir los anuncios al público adecuado, reducir

gastos innecesarios y mejorar futuras campañas al convertir acciones de los usuarios en datos medibles. En conclusión, las matemáticas representan la estructura invisible que permite una publicidad digital más efectiva, precisa y eficiente.

Palabras clave: anuncios en redes sociales, matemáticas, métricas publicitarias, subastas de anuncios, marketing digital

Every time you open Instagram, TikTok, or YouTube, you see ads that seem made just for you. But behind that "magic" is math. Social media platforms use numbers to decide who sees an ad, how much it costs, and if it worked. In other words, math helps make sure that the right people see the right message and that companies don't waste money showing ads to people who don't care.

Before checking if an ad was successful, the platform must confirm that people actually saw it. For example, Facebook and other platforms only count an ad as "seen" when at least half of it appears on your screen for one second. If it's a video, it must stay visible for two seconds. This rule is important because if no one really saw the ad, it doesn't make sense to say it worked.

Once we know people saw the ad, the next step is to count what happened next. They measure things like:

- How many people clicked it?
- How many people did what the ad asked (like watching a full video or buying something).
- How much money was spent and how many results it produced.

Simple math formulas help them compare ads:

- **Click rate** = number of clicks ÷ number of times people saw the ad.
- **Cost per result** = money spent ÷ number of people who did what the ad wanted.

This helps platforms and companies know which ads are doing better.

Every second, many companies want to show you their ad. But there is limited space on your screen. So, the platform does a super quick calculation (like a small contest). It looks at:

- How much each company is willing to pay.

- How likely you are to be interested in that ad.

- Whether the ad is good quality or annoying.

The ad that gets the best score based on all these numbers wins a spot on your screen. This process happens millions of times every minute.

Social media platforms collect information about what you watch, like, or skip. They use that data to guess which ads you'll probably enjoy or respond to. It's like saying, "This person usually likes cooking videos, so maybe they'll like an ad for kitchen tools."

The math behind this is basically about finding patterns which kinds of people like which kinds of things.

Sometimes, a company wants to know if their ad actually caused more people to buy something or if those people would have bought it anyway.
To check this, the platform does a simple experiment: it shows the ad to one group of people and hides it from another group. Then it compares both groups.
If the first group bought more, that means the ad really made a difference.
This is called a "lift test," and it helps show real results instead of just guesses.

Often, people see more than one ad before doing something. For example, you might see a YouTube ad, then a post on Instagram, then a friend's review before finally buying.
Platforms use math to decide which ad deserves more credit.

Sometimes they give all the credit to the last ad you saw; sometimes they share it between all of them. This helps companies understand which ads really matter.

Without math, social media ads would be random. Numbers help:

- Choose who sees what.

- Measure if the ad was visible and effective.

- Avoid wasting money on ads no one cares about.

- Improve ads over time through small changes and tests.

Briefly, math turns advertising from guessing into learning.

Let's imagine two ads:

- **Ad A:** 1,000 people saw it, 50 clicked, and 5 bought.

- **Ad B:** 1,000 people saw it, 20 clicked, and 6 bought.

Both got some results, but if we divide:

- **Ad A** → 5 buyers / $100 spent = $20 per buyer

- **Ad B** → 6 buyers / $120 spent = $20 per buyer

So both ads cost the same per buyer, but Ad B got more total buyers.

That's how math helps choose which ad worked better.

Social media ads are not just about design or creativity, they're about numbers.

Math decides:

- Who sees the ad,

- When it appears,

- How much it costs, and

- Whether it truly worked.

By turning clicks, views, and purchases into numbers, social media platforms can better understand how people respond to ads.Every action whether someone scrolls past, pauses for a few seconds, or decides to buy becomes data that helps improve future ads. This process allows companies to spend their money more wisely, showing ads to people who might actually care about them. It also helps make the advertising experience more balanced and personal, because users are less likely to see random or irrelevant content. In this way, math works quietly behind the scenes, transforming millions of small human actions into meaningful insights. It is the invisible force that keeps the world of online communication and business running more efficiently, fairly, and intelligently one calculation at a time.

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