Show me the Money: Measuring Marketing Performance in F2P Games using Apple's App Tracking Transparency Framework

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Introduction: Growing the user base

- Mobile apps grow their user base by spending in advertising.
- The goal is to keep the user acquisition activities profitable.
- Revenue attribution assigns revenue to an ad campaign.
- Comparing the revenue obtain advertising campaigns versus the spend helps keeping track of which campaigns are profitable.
- Monitoring ROI is done at cohort level rather than user level.

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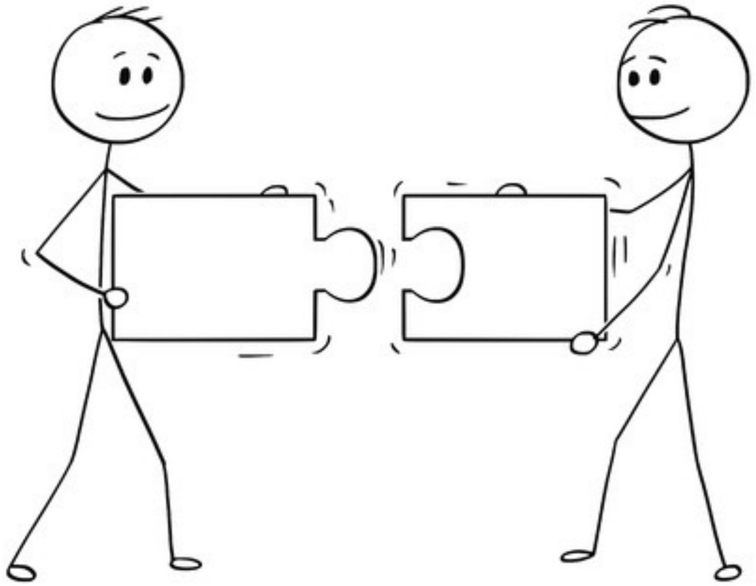
Motivation: Identifiers for advertising



- Comparing revenue and spend has been possible thanks to attribution methods such as last-click attribution.
- Last-click attribution:
  - Assigns the origin of the user to the last campaign the user clicked or saw.
  - Requires advertising identifiers that allows linking clicks and installs.
- The advertising identifiers have created a big concern on how much data can be collected and linked to profiles for advertising.

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Motivation: Privacy innovations

- Starting iOS 14.5+, Apple allows users to choose privacy on advertisement tracking.
- The lack of identifiers for advertising (IDFA) disrupts traditional mechanisms for attributing revenue to advertising campaigns.
- Online advertising has been operating under low uncertainty when it comes to tracking revenue and spend.
- This privacy innovation affects how marketing teams operate advertising campaigns on iOS.

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Motivation: Impact to advertisement

- Various advertising networks reported impact in their revenue during their earnings calls of 2021 Q3.
- Reasons:
  - Lack of tools to measure ROI
  - Campaign optimization algorithms less effective
- Undoubtedly, marketing teams need a way to measure the performance of marketing campaigns under the new privacy preserving mechanisms.

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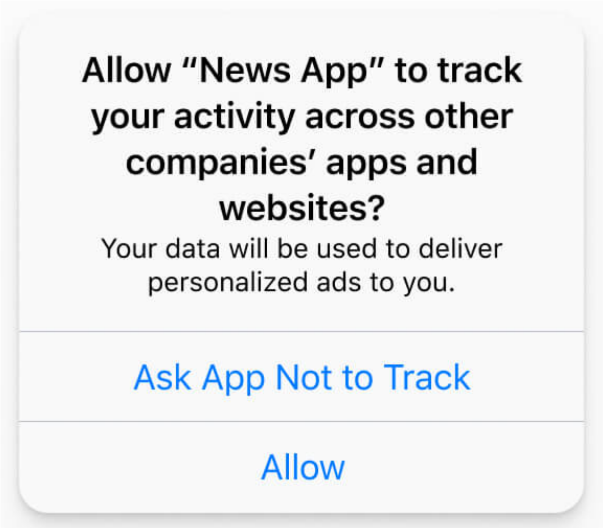
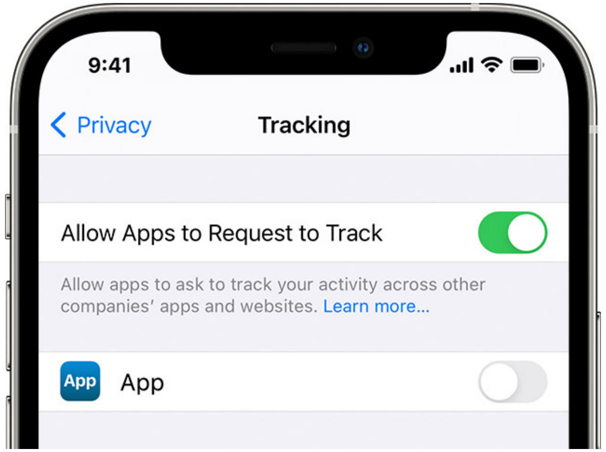
What are the changes?





- Starting iOS14.5+, users can reject sharing any identifier for advertising purposes
- Without identifiers for advertisement, there is no way to connect the app installs to the advertising campaigns.
- For users that do not allow tracking, the campaign performance is reported via the SkAdNetwork and App Tracking Transparency framework.
- App developers receive post-backs containing conversion values.

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What are conversion values?

Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Conversion Value
0	0	0	0	0	0	**0**
0	0	0	0	0	1	**1**
0	0	0	0	1	0	**2**
0	0	0	0	1	1	**3**
0	0	0	1	0	0	**4**
…	…	…	…	…	…	**…**
1	1	1	1	1	1	**63**

- A conversion value is as an integer between 0 and 63 that developers define following a set of rules (see Apple's documentation).
- Users that do not allow tracking will appear as if they would have come organically to the application.
- Conversion values follow last-click attribution and is the only reliable mechanism for it (e.g., fingerprinting is not allowed).
- Under certain circumstances that Apple is not disclosing, the conversion values will be reported as *null* to protect the user's privacy.

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Privacy Protection

$$pr_p(X) = \hat{X} = \begin{cases} \hat{x}_{v,\alpha} = \begin{cases} x_{v,\alpha} & \text{if } \sum_U \mathbb{1}(v_i = v) \geq p \\ \texttt{null} & \text{otherwise} \end{cases} \\ \hat{x}_{\texttt{null},\alpha} = \sum_v \mathbb{1}(\hat{x}_{v,\alpha} = \texttt{null}) \cdot x_{v,\alpha} \end{cases} \tag{1}$$

- In the lack of open rules, we interpret the conversion value mechanism to be like k-anonymity, which requires all users to be indistinguishable from at least $k - 1$ other users.
- On the other hand, it does not warranty privacy because the condition is not enforced on $\hat{x}_{\texttt{null},\alpha}$
- Keep in mind that this is our interpretation, and that the real definition is not disclosed.

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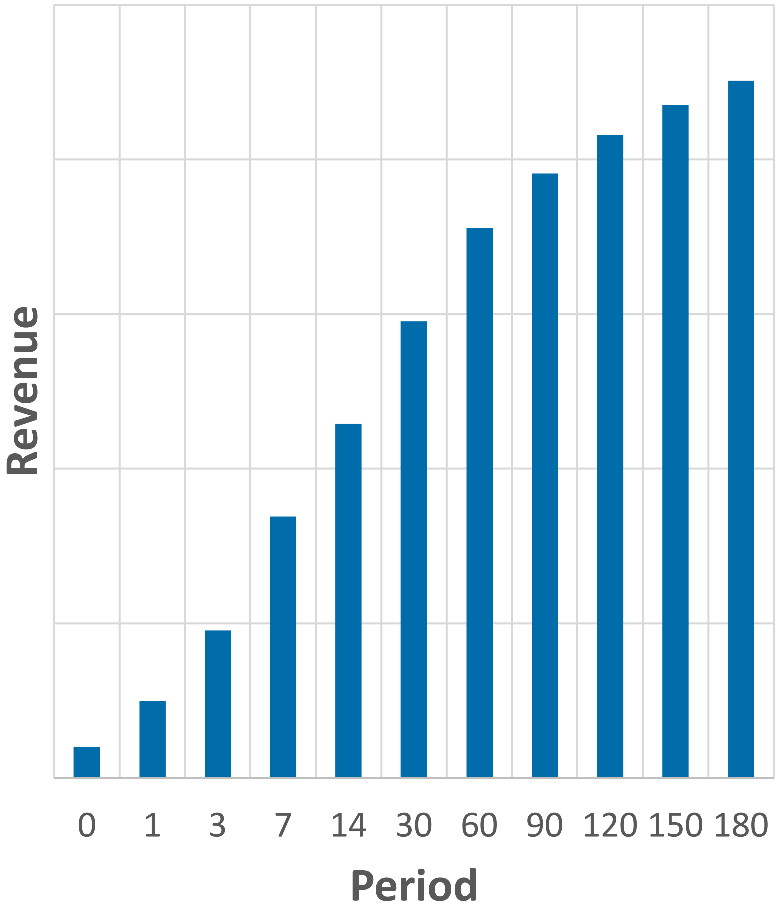
Revenue attribution using conversion values



- When we talk about revenue attribution, we mean translating the reported counts of conversion values to revenue.
- We focus on attributing revenue to cohorts.
- A cohort is a group of users that started using the app at the same time.
- Looking at how much revenue the cohorts have generated at a certain period (e.g., 7, 14, 30 days) provide early signals to determine if the cohort will generate enough money to cover the investment or not.

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Proposed Method

- The attribution error minimization problem is defined as:

$$\min_{f}\left[\sum_{\alpha}\left(\sum_{v} g\left(\tilde{U}_{v}^{d},\hat{x}_{v,\alpha}^{d}\right)-y_{\alpha}^{t}\right)^{2}\right] \tag{2}$$

- Independently of the conversion value scheme f, the function g that minimizes equation (2) when there is no privacy threshold (i.e., p = 1) is the product of the count of conversion value by the average revenue of users with such a conversion values.:

$$g_{\alpha}\left(\tilde{U}_{v}^{d},x_{v,\alpha}^{d}\right)=x_{v,\alpha}^{d}\cdot\bar{r}_{v}^{t} \tag{3}$$

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Proposed Method

- When there is a privacy threshold (i.e., p >= 2) we need to account for the *null* conversion value.
- We propose two attribution formulas:

$$g_\alpha\left(\tilde{U}_v^d, x_{v,\alpha}\right) = \begin{cases} \bar{r}_v^t \cdot \hat{x}_{v,\alpha} & \text{if } \hat{x}_{v,\alpha} \neq \texttt{null} \\ \bar{r}_v^t \cdot h(\cdot) \cdot \sum_U \mathbb{1}(v_i = v) & \text{otherwise} \end{cases} \quad (4)$$

- Where $h(\cdot)$ can be:
  - Uniform Revenue Attribution (**U**): Distributes revenue uniformly across networks and campaigns.
  - Null-based Revenue Attribution (**N**): Distribute the revenue based on the empirical distribution of *null* values.
- **Let's look at an example!**

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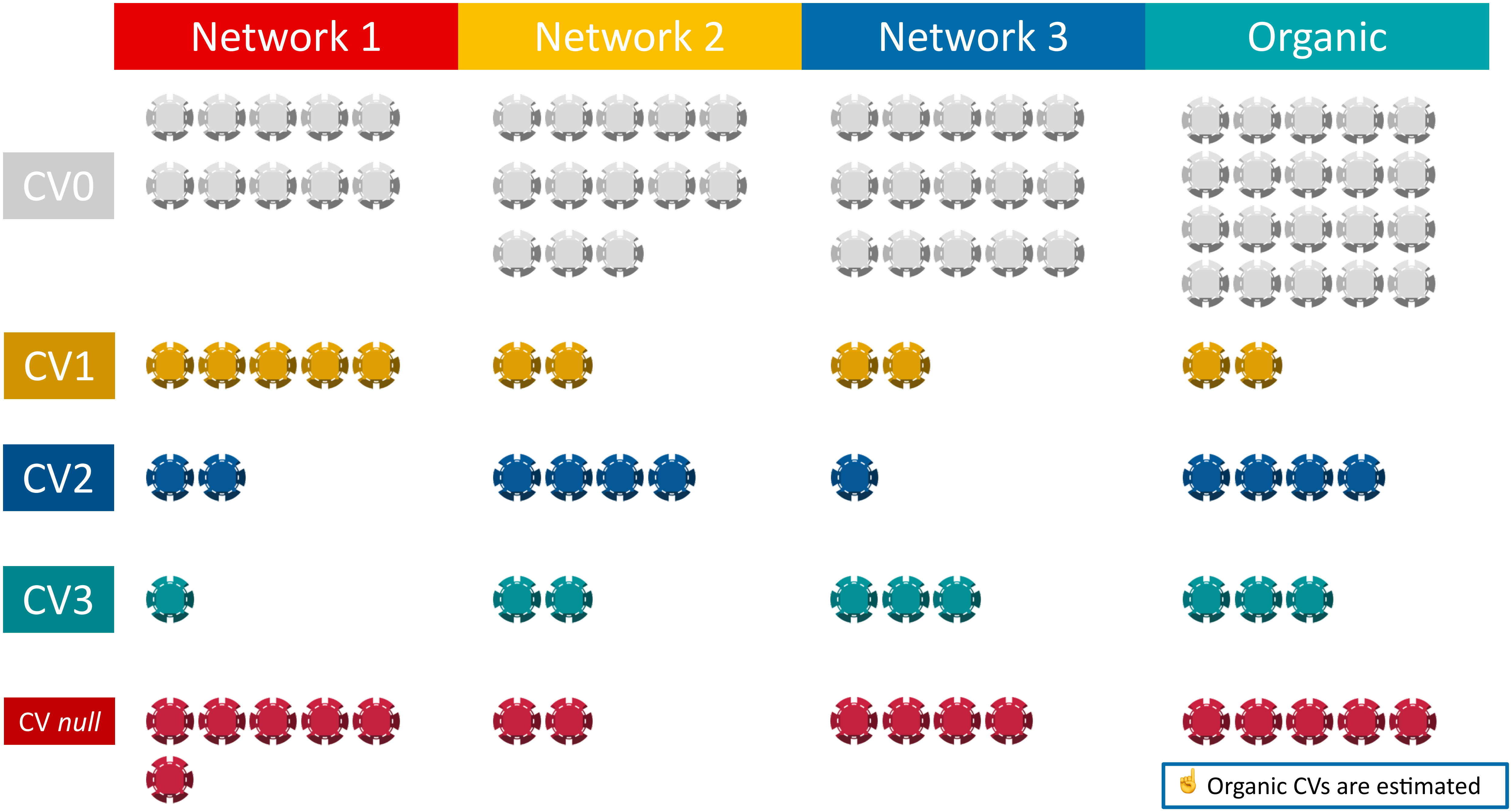

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Avg. Revenue per CV	
Conversion Value (CV)	**Day 7**
0	$ 0.02
1	$ 0.15
2	$ 0.50
3	$ 1.00

Count of Conversion Values			
Network 1	**Network 2**	**Network 3**	**Organic** Estimated
10	13	15	*20*
5	2	2	*2*
2	4	1	*4*
1	2	3	*3*

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*Count of CV * Average Revenue =*	Revenue Attribution			
	Network 1	Network 2	Network 3	Organic
Revenue CV1	$ 0.23	$ 0.30	$ 0.35	$ 0.46
Revenue CV2	$ 0.75	$ 0.30	$ 0.30	$ 0.30
Revenue CV3	$ 1.00	$ 2.00	$ 0.50	$ 2.00
Revenue CV4	$ 1.00	$ 2.00	$ 3.00	$ 3.00
Known CVs revenue	$ 2.98	$ 4.60	$ 4.15	$ 5.76

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Totals	D7 Revenue	
Total revenue	$ 30.00	<- Known from all the revenue of the users
Known CVs revenue	$ 17.48	
Pending attribution	$ 12.52	

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$$\frac{Total\ Revenue\ -\ Revenue\ Known\ CVs}{Total\ nulls}$$

null	$ 0.74

$$\frac{Network\ nulls}{Total\ nulls} =$$

Total *nulls*	6	2	4	5
***null* distribution**	*0.35*	*0.12*	*0.24*	*0.29*

*= total null count * null average revenue * null distribution*

***null* CVs revenue**	$ 4.42	$ 1.47	$ 2.94	$ 3.68

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*= total null count * null average revenue * null distribution*

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Network Revenue	$ 7.40	$ 6.07	$ 7.09	$ 9.44

Totals	D7 Revenue
Total revenue	$ 30.00
Known CVs revenue	$ 17.48
Pending attribution	$ 12.52
Attributed Revenue	$ 30.00

<- Known from all the revenue of the users

✓ Matches the total revenue

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Experiments

- Using historical data allows us to compare the attributed revenue with the actual data from last-click attribution:
  - Back tested on historical data of a globally launched free-to-play game.
  - More than 500K paid players.
  - Organic and 213 paid campaigns across seven networks.
- Conversion value schemas:
  - Day 0 event-based (**EV**)
  - Rolling Revenue & Rolling Purchase Count (**RR** & **RI**)
  - Uniform distribution (**UD**)
  - Perfect lifetime value (**PV**)

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Results

✓When there is no privacy threshold the error with baseline schema using D30 PV is smaller than all others, and UD performs the worst.

✓As p increases, the D0 event-based and Uniform Distributed schemas' performance gets closer to the rest of the schemas.

✓Using a more extended period than the first 24 hours of gameplay reduces the attribution error.

✓RR and and RI work well if enough players are spending during the observed period.

✓Empirical results suggest that schemas that separate spenders and non-spenders and group users based on their spending are the most helpful for revenue attribution.

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Conclusions

- ✓ Our work formalizes and investigate the conversion values for revenue attribution rigorously.
- ✓ We find the optimal revenue attribution function that does not depend on the conversion value scheme.
- ✓ We shed light on how different conversion value schemas perform in revenue attribution.
- ✓ Separating spenders and non-spenders and then grouping users based on their spending gives the lowest error in revenue attribution.

Thanks! If you have questions please reach out:

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