
Targeted Advertising on Social Media: Transparency, Control, Fairness, Privacy

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Ad targeting in social media

- ❑ This talk: Focus on **Facebook** social media platform
 - ❑ By far, the **largest social media platform**
 - ❑ In terms of **number of users**
 - ❑ In terms of **data aggregated on users**
 - ❑ In terms of **advertisers & ad revenues**
 - ❑ Leader in introducing **novel targeting practices**
 - ❑ However, the issues **generalize** to other social media platforms
 - ❑ Like LinkedIn, Twitter, YouTube, Instagram etc.,
-

Background: Ad targeting on Facebook

Ads on Facebook



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Data used for targeting ads

- Facebook gathers lots of data (features) on users

Category	Behaviors														Demographics										Interests							Total				
	Anniversary	Consumer Class.	Digital activities	Experts	Mobile Device User	Multicultural Affinity	Seasonal and Events	Travel	Automotive	Charitable donations	Financial	Job role	Media	Purchase behavior	Residential profiles	Business-to-business	Education level	Generation	Home	Life Events	Parents	Politics (US)	Relationship status	Work	Financial	Business and industry	Entertainment	Family/relationships	Fitness and wellness	Food and drink	Hobbies and activities		Shopping and fashion	Sports and outdoors	Technology	Other
Facebook	1	2	39	74	81	6	2	5								13	3	2	36	9	8	16	26		39	70	8	11	37	60	21	22	21	2	614	
Acxiom								1	5	25	2	35	23	2				19						16												128
Epsilon									4	1												2														14
Experian																			1																	5
Datalogix							11	151			1		144		29			2	11				1													350
Total	1	2	39	74	81	6	2	16	152	9	26	3	35	175	5	29	13	3	24	36	20	10	16	27	16	39	70	8	11	37	60	21	22	21	2	1,111

Closer look at features: Examples

- ❑ **Demographical (gathered by Facebook)**
 - ❑ **Relationship:**
 - ❑ **Interested In:** Men and Women, Men, Unspecified, Women
 - ❑ **Status:** Separated, Widowed, Open Relationship, Divorced, In a relationship, Married, Engaged, Unspecified, Single, Complicated Civil Union, Domestic Partnership
 - ❑ Each user feature is a **boolean variable**
 - ❑ **Demographical (aggregated from data brokers)**
 - ❑ **Financial:**
 - ❑ **Income:** Geschätztes monatliches Nettoeinkommen 2.000 bis 2.600, 2.600 bis 3.600, 3.600 bis 5.000, über 5.000 Euro
-

Data aggregation across countries

Country	Facebook	Epsilon	DLX	Experian	Acxiom	Total
US	598	14	350	5	128	1105
UK	598	0	19	17	103	737
France	598	0	0	0	21	619
Germany	598	0	0	0	60	658
Australia	598	0	0	34	24	656
Brazil	598	0	0	20	0	618
Japan	598	0	0	0	17	615
South Korea	598	0	0	0	0	598
Canada	598	0	0	0	0	598
India	598	0	0	0	0	598

How Facebook advertisers target users

1) **Traditional targeting**: Advertisers specify a **boolean formula** over the features

- Typically, in a **restricted CNF** form
 - $(F_1 \vee F_2 \vee F_3 \dots) \wedge (F'_1 \vee F'_2 \vee F'_3 \dots) \wedge \dots \wedge -F_K \wedge -F'_K$
- Users are targeted, when their **feature values** inferred by Facebook **satisfy the targeting formula**

How Facebook advertisers target users

2) Custom audience targeting: Advertisers upload PII of users they wish to target

Create a Custom Audience ✕

- 1** Add Customer List
- 2 Edit Data Mapping
- 3 Hashed Upload & Creation
- 4 Next Steps

Prepare a file with your customer data

🔗 [Read best practices for preparing your customer data](#) ✕

Identifiers you can use (15) ?

Email	Phone Number	Mobile Advertiser ID	First Name	Last Name	ZIP/Postal Code	
City	State/Province	Country	Date of Birth	Year of Birth	Gender	Age
Facebook App User ID	Facebook Page User ID					

Add a new file (CSV or TXT) Download file template

Drag and drop your file here or Upload File

How Facebook advertisers target users

2) Custom audience targeting: Advertisers upload PII of users they wish to target

Site	Name	Email	Phone number	City or ZIP	State or Province	Birthday, Gender	Employer	Site user ID	Mobile advertiser ID
Facebook	✓	✓	✓	✓	✓	✓	✗	✓	✓
Instagram	✓	✓	✓	✓	✓	✓	✗	✓	✓
Twitter	✗	✓	✓	✗	✗	✗	✗	✓	✓
Google	✓	✓	✓	✓	✗	✗	✗	✓	✓
Pinterest	✗	✓	✗	✗	✗	✗	✗	✗	✓
LinkedIn	✗	✓	✗	✗	✗	✗	✓	✗	✓

□ Advertisers love custom audience

This talk: 4 Aspects of Ad Targeting

1. **Transparency**
 2. **Control**
 3. **Fairness**
 4. **Privacy**
-

This talk: 4 Aspects of Ad Targeting

1. **Transparency**
'18]

[NDSS

2. **Control**

3. **Fairness**
'18]

[FAT

4. **Privacy**
'18]

[S&P

This talk: 4 Aspects of Ad Targeting

1. Transparency

- Can I know what data about me is used to target ads?

2. Control

3. Fairness

4. Privacy

Transparency of Facebook ad targeting

- Facebook provides transparency via **explanations**

The screenshot shows a Facebook ad for TransferWise with a transparency overlay. The overlay is titled "About This Facebook Ad" and contains the following text:

Why Am I Seeing This Ad?

One of the reasons you're seeing this ad is because we think you may be in the **"Expats (India)"** audience. This is based on what you do on Facebook.

There may be other reasons you're seeing this ad, including that TransferWise wants to reach **people ages 21 and older who live in Germany**. This is information based on your Facebook profile and where you've connected to the internet.

At the bottom of the overlay is a link: [Manage Your Ad Preferences](#)

On the right side of the overlay, there is a menu with the following options:

- Save video (Add this to your saved items)
- Hide ad (See fewer ads like this)
- Report ad (Mark ad as offensive or inappropriate)
- Why am I seeing this?
- Create Similar Ad
- Turn on notifications for this post (This ad is useful)
- Embed
- More options

- Largely **voluntary**
 - At times to **satisfy legal requirements**

The thumbnail shows a Facebook ad for TransferWise. The text in the ad reads: "do banks charge? I have absolutely no clue". Below this, it says: "Stop using your bank, they are charging you a lot of money!". At the bottom, there is a link: [Learn More](#) and the website name: TRANSFERWISE.COM.

Explanations are great, but are they...

- ❑ Complete?
 - ❑ Correct?
 - ❑ Personalized?
 - ❑ Deterministic?
 - ❑ Useful?
-

Need standards for explanations

To guard against **adversarial explanations**:

- ❑ **Insufficient / unsatisfactory** explanations
 - ❑ That offer no insightful / actionable information to consumers
 - ❑ **Misleading / fake** explanations:
 - ❑ Designed to influence consumers to behave a certain way
 - ❑ Designed to gain consumer acceptance for a service
-

How complete are the explanations?

- ❑ For ads targeting **customer PII**:
 - ❑ *"One reason you're seeing this ad is that [Booking.com](#) wants to reach people who have visited their website or used one of their apps. This is based on [customer information](#) provided by [Booking.com](#)."*
 - ❑ Doesn't state **what PII Booking.com used!**
 - ❑ E.g., Did booking.com use email? Or phone number? Or name/address?
-

How complete are the explanations?

- ❑ For ads targeting **data broker info**:
 - ❑ *"One reason you're seeing this ad is that Peugeot wants to reach people who are part of an audience created based on data provided by Acxiom. Facebook works with data providers to help businesses find the right audiences for their ads. Learn more about data providers."*
 - ❑ Doesn't state **what Acxiom provided data** was used!
 - ❑ E.g., is it based on financial data? Or purchasing habits?
-

How complete are the explanations?

- For ads targeting **FB user data**:
 - Beyond location, gender, age: picks **exactly one** of the several features used in targeting formula
 - *"One reason you're seeing this ad is that Peek & Cloppenburg wants to reach people interested in Shopping and fashion, based on activity such as liking Pages or clicking on ads."*
 - *"There may be other reasons why you're seeing this advert, including that Acer wants to reach people aged 18 to 45 who live or have recently been in Germany. This is information based on your Facebook profile and where you've connected to the Internet."*
-

Validation of incompleteness

- ❑ Ran a **controlled ad** targeting ourselves using a **custom list** and selecting **millennials & expats**
 - ❑ *"One of the reasons why you're seeing this advert is because we think that you may be in the **Millennials** audience. This is based on what you do on Facebook.."*
 - ❑ Only one feature, **millennials (not expats)**, shown!
-

Worse, the explanations are misleading!

- ❑ Ran a **controlled ad** targeting ourselves using a **custom list** and selecting **millennials & expats**
 - ❑ *"There **may be other reasons** why you're seeing this advert, including that Acer wants to reach **people aged 18 and above who live or have recently been in Germany**. This is information based on your Facebook profile and where you've connected to the Internet."*
 - ❑ **Never used features** shown in explanations!
-

Do explanations need to be complete?

- ❑ Should they specify **all features in ad targeting?**
 - ❑ Arguments **for**:
 - ❑ **Avoids misleading / fake** explanations:
 - ❑ Designed to gain consumer acceptance for a service
 - ❑ **Builds trust** and incentivizes cooperation
 - ❑ Arguments **against**:
 - ❑ Targeting formula may be a **business secret**
 - ❑ **Overloads users** with information
 - ❑ Need succinct explanations
-

Selecting features for explanations

- Example explanation:

"One reason you're seeing this ad is that Peek & Cloppenburg wants to reach people interested in Shopping and fashion, based on activity such as liking Pages or clicking on ads."

- Are the explained features **the most important**?
 - Is Shopping and fashion the most important of all the user' features that Facebook and the advertised used to target the user?
-

How Facebook selects features to explain

- ❑ Ran **controlled ads** to **reverse-engineer** Facebook's feature selection strategy
 - ❑ Facebook appears to **prioritize features** based on
 - ❑ **Their type**: Demographic > Interest > PII > Behavioral
 - ❑ **Their prevalence**: Most prevalent first
 - ❑ Unclear, if this is the **right prioritization** for users
-

Open challenges

- ❑ How to pick **a few (K) features** for explanations?
 - ❑ How to determine the **importance of a user feature**?
 - ❑ Does it reveal **privacy sensitive information**?
 - ❑ Is it a **rare (or low prevalence) feature in population**?
 - ❑ Does it exert **the most influence**?
 - ❑ On sizing the target audience?
 - ❑ As measured by “Quantifying Input Influence” framework?
-

This talk: 4 Aspects of Ad Targeting

1. Transparency

- ❑ Can I know **what data about me is used to target ads?**
- ❑ **NO! Only some (not all)** data used is revealed

2. Control

3. Fairness

4. Privacy

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- ❑ Do explanations offer consumers **satisfactory control?**

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Useful explanations enable control

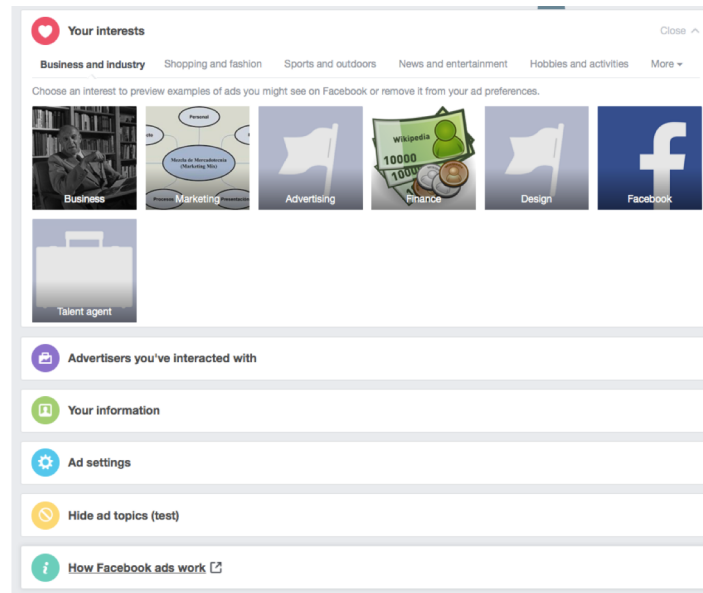
Consumer control over ads

- Control **Inputs**: Determine **data used for targeting** ads
 - Help consumers protect their privacy

 - Control **Outputs**: Determine **ads they receive**
 - Help consumers achieve specific decision outcomes
-

Consumer controls in Facebook

- Facebook claims that **ad preferences page** allows **control** over what ads users see



- In reality, it offers **controls over inputs, not outputs!**

Do explanations offer output control?

- Given the **incompleteness** of explained features:

"One reason you're seeing this ad is that Peek & Cloppenburg wants to reach people interested in Shopping and fashion, based on activity such as liking Pages or clicking on ads."

- Are the explained features **necessary**?
 - If the user asked Facebook to **remove their data on shopping and fashion**, would they **stop receiving the ad**?
 - **No guarantees!**
-

Do explanations offer output control?

- Given the **incompleteness** of explained features:

"One reason you're seeing this ad is that Peek & Cloppenburg wants to reach people interested in Shopping and fashion, based on activity such as liking Pages or clicking on ads."

- Are the explained features **sufficient**?
 - If the user asked Facebook to **change their data on features other than shopping and fashion**, would they continue to receive the ad?
 - **No guarantees!**
-

Open challenges

- ❑ Given the **incompleteness** of explained features
 - ❑ How to construct **necessary/sufficient** explanations?
 - ❑ Technically **challenging** for arbitrary targeting formulae!
 - ❑ Finding **min. set of necessary or sufficient features**
 - ❑ Often, maps to solving **NP-Complete SAT** problem
 - ❑ But, can leverage recent **advances on SAT solvers!**
-

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3. Fairness

- ❑ Can we **detect & prevent** discriminatory ad targeting?

4. Privacy

Can ad targeting be discriminatory?



[Online Ads for High-Paying Jobs Are Targeting Men More Than ...](#)
Adweek - 7 Jul 2015

"We found small instances where there was **discrimination** and **gender-based discrimination** in job ads," said ... The issue of bias and **discrimination** in ad targeting isn't new, ... The **Carnegie Mellon researchers** also were alarmed by ads that ... (Google's rules forbid serving ads based on health information.).

[Carnegie Mellon Study Finds Gender Discrimination In Ads Shown ...](#)
Marketing Land - 8 Jul 2015

[When Algorithms Discriminate](#)

New York Times - 9 Jul 2015

[Probing the Dark Side of Google's Ad-Targeting System](#)

Highly Cited - MIT Technology Review - 6 Jul 2015

[Google's Ad System Has Become Too Big to Control](#)

In-Depth - Wired - 9 Jul 2015

[Google's algorithm shows prestigious job ads to men, but not to ...](#)

Highly Cited - Washington Post - 6 Jul 2015



Marketing Land



New York Tim...



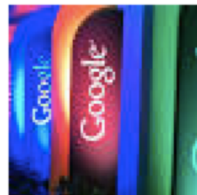
The Guardian



Washington P...



Chicago Tribu...



TechCrunch

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Can ad targeting be discriminatory?



[Facebook To Ban 'Ethnic Affinity' Targeting For Housing ...](#)

Forbes - 11 Nov 2016

After weeks of push back from U.S. lawmakers, media and civil rights leaders, Facebook FB +0.18% on Friday announced it will stop allowing ...

[Facebook disables 'ethnic affinity' ads for housing, jobs](#)

Engadget - 11 Nov 2016

[Facebook to stop ads that target, exclude races](#)

Highly Cited - USA TODAY - 11 Nov 2016

[Facebook to Remove 'Ethnic Affinity' Targeting From Certain Ad ...](#)

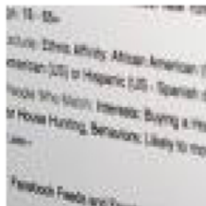
International - AgencySpy - 11 Nov 2016

[Facebook has discriminated against you, and it's not going to stop](#)

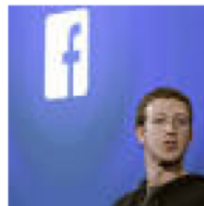
In-Depth - Mashable - 12 Nov 2016

[Facebook Bans Targeting Based on Race and Ethnicity for Housing ...](#)

Blog - Slate Magazine (blog) - 11 Nov 2016



Engadget



TechCrunch



Deadline



Daily Mail



SlashGear



USA TODAY

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Facebook's first defense

- ❑ Ethnic affinity is not ethnicity
- ❑ Can we verify how correlated they are?
- ❑ Used voter records from NC to check correlations
 - ❑ Voter records have race information
 - ❑ Created separate customer lists for different races
 - ❑ Checked correlations between their race & ethnic affinity

Attribute	Voter Records		Facebook Users					
	Number	Percent	Uploaded	Matched	Reachable	Reachable %	Corresponding	Corresponding %
White	5,303,383	70.1%	10,000	8,000	6,800	85.0%	5,700	83.8%
Black	1,694,220	22.4%	10,000	7,800	6,300	80.8%	5,200	82.5%
Asian	79,250	1.0%	10,000	7,700	6,600	85.7%	1,900	28.8%
Hispanic	163,236	2.2%	10,000	7,000	5,900	84.3%	3,000	50.8%

Does banning “ethnic affinity” help?

- What about **pre-filtered custom lists**:
 - **using offline info** like voter records?
- What of other **correlated features**?

no	feature name	selectivity	Blacks percentage	rest percentage	ratio
1	Demographic > Ethnic Affinity > African American (US)	17.0%	77.0%	10.9%	7.06
2	Demographic > Politics (US) > US Politics (Very Liberal)	11.8%	49.8%	7.7%	6.44
3	Interests > Entertainment > Music > Gospel music	14.4%	48.3%	14.6%	3.32
4	Interests > Shopping and fashion > Beauty > Hair products	12.2%	40.8%	12.9%	3.15

no	feature name	selectivity	Blacks percentage	rest percentage	ratio
1	Demographic > Politics (US) > US Politics (Very Conservative)	14.4%	4.8%	26.5%	0.18
2	Demographic > Politics (US) > US Politics (Conservative)	16.6%	6.5%	29.7%	0.22
3	Interests > Sports and outdoors > Outdoor recreation > Hiking	11.0%	8.0%	21.6%	0.37
4	Interests > Sports and outdoors > Outdoor recreation > Camping	11.4%	11.5%	22.8%	0.50

Open challenges

- ❑ How to **detect discriminatory targeting** in ads?
 - ❑ Particularly, with customer lists?
 - ❑ How to **avoid discriminatory targeting** in ads?
 - ❑ Detecting & avoiding algo. discrimination is a **hot topic**
 - ❑ But, even here ads pose **unique challenges**
 - ❑ **Fair targeting** might result in **unfair ad impressions!**
 - ❑ Targeting 100 men & 100 women might result in unequal impressions, when **costs of their impressions are different!**
-

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3. Fairness

- ❑ Can we **detect & prevent** discriminatory targeting?
- ❑ **Unclear** – need **new measures & methods** for fairness

4. Privacy

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4. Privacy

- ❑ Are there any **privacy risks** with targeted ads?
-

Potential audience reach estimate

- A feature of Facebook's **advertiser interface**

The screenshot displays the Facebook advertiser interface for creating a new audience. The main section is titled "Create New" and "Use a Saved Audience". Under "Custom Audiences", a "Customer List" named "list_of_9444_records" is selected. The "Locations" section is set to "Everyone in this location". The "Age" range is "18 - 65+", "Gender" is "Men", and "Languages" is empty. The "Detailed Targeting" section is set to "INCLUDE people who match at least ONE of the following".

On the right side, the "Audience Definition" section shows a gauge indicating the audience is defined. Below it, "Audience Details" lists: Custom Audience: list_of_9444_records; Age: 18 - 65+; Gender: Male; Placements: Facebook Feeds and Instagram Feed.

The "Potential Reach: 2,600 people" is highlighted with a green box. Below it, the "Estimated Daily Reach" is shown for Facebook (520 - 1,400 people) and Instagram (270 - 530 people).

The accuracy of estimates is based on factors like past campaign data, the budget you entered and market data. Numbers are

Privacy risks from audience estimates

- ❑ Assume **exact estimates** of audience size
 - ❑ Then, **given a user's PII**
 - ❑ Like phone-num. or email-id. or name-address
 - ❑ Any advertiser can **check if the user is on Facebook**
 - ❑ And **match different PII**s linked to a Facebook user
 - ❑ Link emails to mobile phone numbers or,
 - ❑ Link Facebook pixels to phone numbers
-

The dangers of linking user PII's

THE EXPRESS TRIBUNE · PAKISTAN

Facebook turns down Pakistan's request to link accounts with mobile numbers

By Tech Desk Published: July 15, 2017

492
SHARES

f SHARE

🐦 TWEET

✉ EMAIL

Pakistan's mobile phone owners told: be fingerprinted or lose your sim card

Government launches mass drive to gather biometric data from mobile owners in attempt to combat terrorism

Hackers Are Hijacking Phone Numbers And Breaking Into Email, Bank ...

<https://www.forbes.com/.../hackers-are-hijacking-phone-numbers-and-breaking-into-e...> ▼

Dec 21, 2016 - If you port your main number to Google Voice, you should still separate your main email address from that used for your other sensitive accounts so if your ... Passwords can easily be stolen through phishing attacks in which the hacker poses as a legitimate service and asks the user to enter their password ...

Precision of audience reach estimates

- ❑ **Reverse-engineered** how the estimates work
 - ❑ **No estimates** given when the **audience reach** < 20
 - ❑ **Estimates are rounded**
 - ❑ Audience reach < 1000 , rounded down to closest 10
 - ❑ Audience reach < 10000 , rounded down to closest 100
 - ❑ Audience reach < 100000 , rounded down to closest 1000
 - ❑
-

Privacy risks from audience estimates

- ❑ Given any customer list S with and a user U 's PII
 - ❑ Like phone-num. or email-id. or name-address
 - ❑ Create a new customer list with $S + U$
 - ❑ Is audience reach for $S + U$ is more than S ?
 - ❑ If it does, user U is on FB
 - ❑ One can similarly retrieve all the info FB has on the user
 - ❑ If not, either U is not on FB OR it's a rounding error
-

The probability of rounding errors

- ❑ For a list S with audience reach > 20 & < 1000
 - ❑ Rounding error probability is 0.9
 - ❑ For K -lists with audience reach > 20 & < 1000
 - ❑ Chance of every try suffering a rounding error is 0.9^K
 - ❑ Chance of at-least one try not being rounded is $1 - 0.9^K$
 - ❑ For $K = 100$, this is chance is 99.999974%
 - ❑ So **by creating 100 lists** with reach > 20 & < 1000
 - ❑ One can **w.h.p. retrieve all data FB has on any user**
-

How to create such customer lists

- ❑ Use **public voter records** in the US!
 - ❑ Randomly sample names/addresses from records
 - ❑ Till you get a customer list of size > 20 & < 1000 !
 - ❑ Repeat the process 100 times!
 - ❑ **Validation**: **Linked email ids** of multiple users in US, Germany, and France to their **phone numbers**!
 - ❑ Worked with Facebook to deploy a fix for linking PII's
-

Open challenges

- ❑ Online ad APIs are becoming rich and **complex**
 - ❑ Facebook's ad interface might have more vulnerabilities
 - ❑ Facebook is just one of **several online ad platforms**
 - ❑ Google, Twitter, and others have own set of ad APIs
 - ❑ How can one **systematically analyze data broker ad APIs for privacy vulnerabilities?**
-

Summary: Ad Targeting on Social

Media

1. Transparency

[NDSS

'18]

- Limited! Only some (not all) data used for is revealed

2. Control

- Limited! Providing satisfactory explanations is non-trivial

3. Fairness

[FAT

'18]

- Unclear! Need new measures & methods for fairness

4. Privacy

[IEEE S&P '18]

- Vulnerable! Avoiding data leaks via ads is non-trivial!
-