All Your Face Are Belong to Us: Breaking Facebook's Social Authentication

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Outline

- Introduction
- Social Authentication
- Breaking Social Authentication
- Experimental Evaluation
- Remediation Measures
- Discussion
- Conclusions

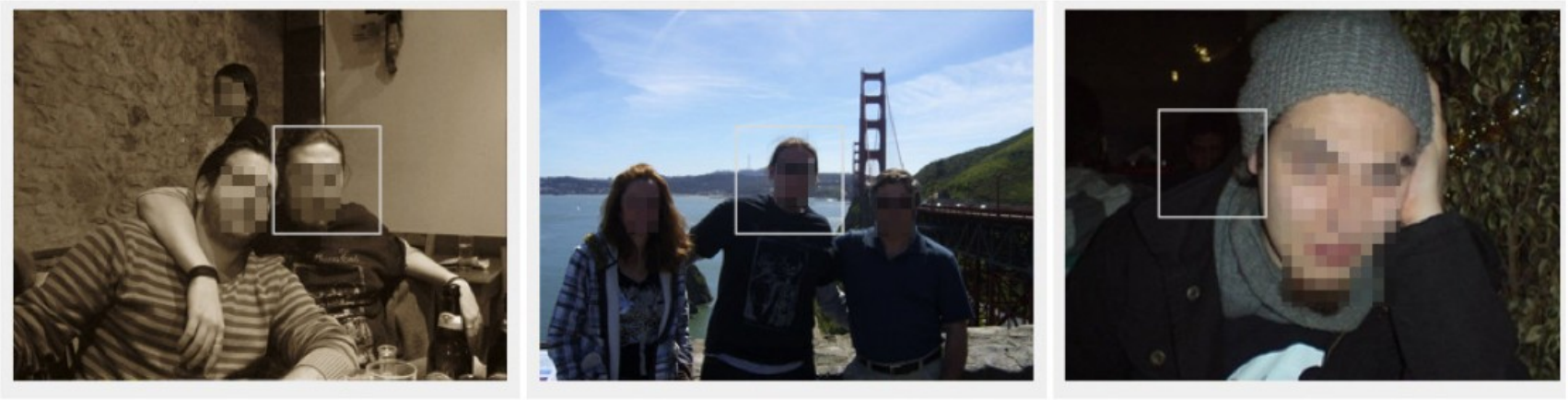
Introduction

- Social Networks
  - Massive user base (Facebook: 1 Billion active users)
  - Appealing targets
- Compromised accounts sold in underground markets
- Majority of spamming accounts compromised, not fake [Gao et al., IMC 2010]
- Recent Facebook phishing attacks
  - Use compromised accounts
  - Steal personal info
  - Social engineering

Social Authentication (SA)

- Two-factor authentication scheme
  - 2nd factor: something user knows
  - Difficult for the attacker to learn
- More user-friendly
  - No need for physical tokens
  - Easy for people to recognize their friends
  - People accustomed to tagging friends (creating the labeled dataset for Facebook)

Social Authentication (SA)



- 7 challenges
- 3 photos per challenge
- 6 possible answers
- User has to correctly answer 5/7 challenges

Motivation

“Can adversaries break SA in an automated manner?”

Triggering Social Authentication

- When log-in considered suspicious
  - From geo-location never seen before
  - From device never seen before
- Requirements
  - Friend list: 50 Friends
    - Gradually increased # of friends in dummy accounts
  - Tagged photos
    - Friends must be tagged in adequate # of photos

SA Photo Selection

"Are photos randomly selected?"

- 2,667 SA photos from real SA tests checked
  - 84% containing faces in manual inspection
  - 80% in automatic inspection by software
- 3,486 random Facebook photos checked
  - 69% contained faces in manual inspection

➢ Face detection procedures used for selecting photos with faces

SA shortcomings

- Number of friends influences usability
  - Difficult for users with many friends
  - Dunbar's number
- Content of photos
  - May not contain faces, or even the user tagged
  - Initial user feedback expressed frustration
- Current implementation by Facebook
  - Users can bypass SA by entering date of birth
    - Trivial for attackers to obtain

Threat model

- SA considered safe against adversaries that
  - Have stolen credentials
  - Are *strangers* (not members of the victim's social circle)

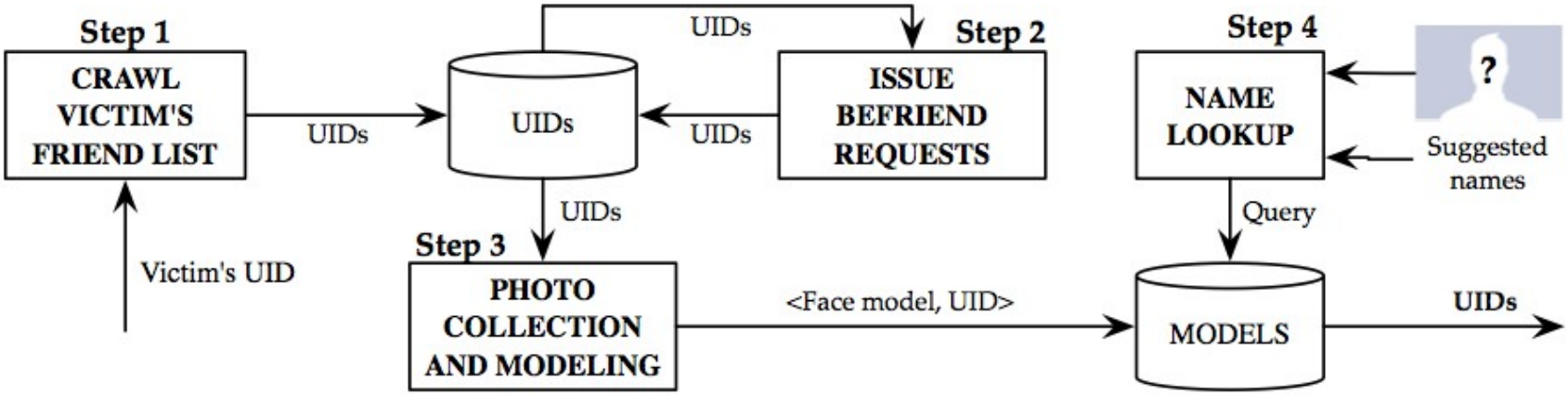
- Not safe against friends or family
- Or any tightly connected network (e.g. University) [Kim et al., FC '12]

- We demonstrate SA not safe even against strangers
  - Publicly available data
  - Face recognition software

Attack Scenarios

- Casual Attacker
  - Collects publicly available data
- Determined Attacker
  - Penetrates victim's social circle
    - Befriends victim's friends
  - Employs fake accounts
    - Different characteristics appeal to different demographics [Irani, DIMVA '11]
  - Collects as much private data as possible

Breaking Social Authentication



1. Crawling Friend List (offline)
   - Crawler retrieves names and UIDs of target's friends
2. Issuing Friend Requests (offline, optional)
   - Can use dummy accounts
3. Photo Collection/Modeling (offline)
   1. Photo collection
   2. Face extraction and Tag matching
   3. Facial Modeling
4. Name Lookup

Face recognition

- Custom solution
  - Based on OpenCV library
  - \+ Versatility in parameter tuning
  - \+ Offline
  - \- Not as accurate
- Cloud Service
  - Face.com (subsequently acquired by Facebook)
  - Exposes API to developers
  - \+ Superior accuracy
  - \- API rate limiting

Experimental Evaluation

- We collect data as *casual attackers* (publicly available data)
  - We have not compromised or damaged any user accounts (as if I'd ever tell... :-)
- Determined attacker experiment
  - Through simulation
  - Custom face recognition software (flexible)
- Casual attacker experiment
  - Using face.com (accurate)

Dataset

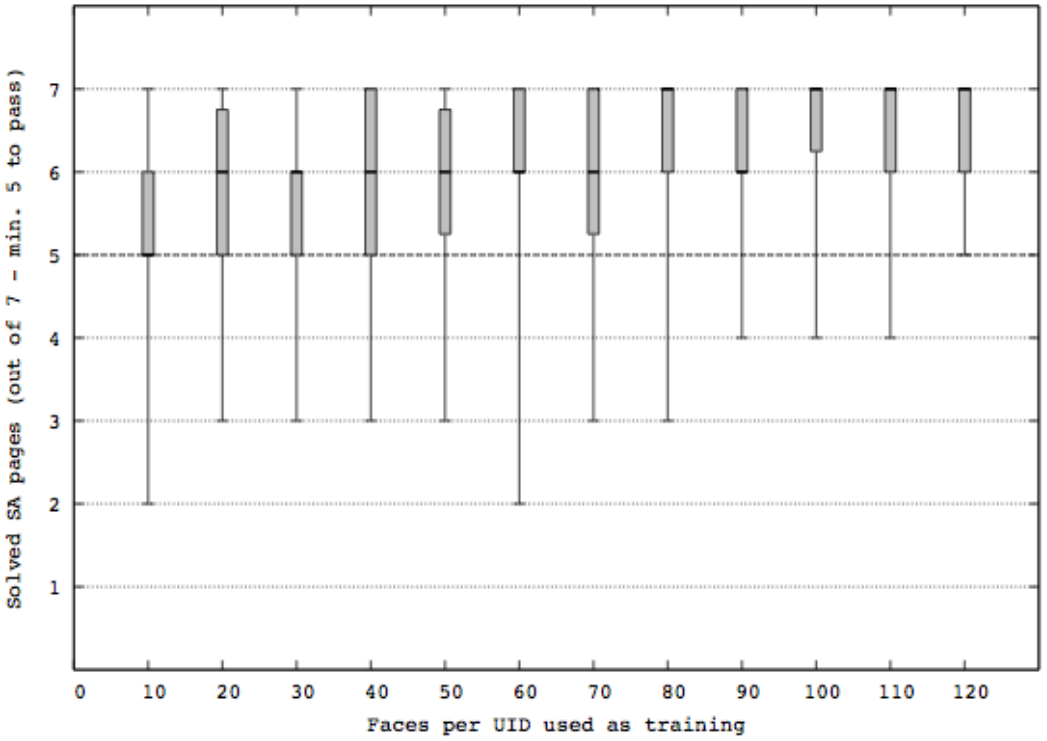
	Total	Public	Private
UIDs	236,752	167,359	69,393
Not tagged	116,164	73,003	43,161
Tagged	120,588	94,356	26,232
Mean tags per UID:		19.39	10.58
Tags[9]	2,107,032	1,829,485	277,547
Photos	16,141,426	16,141,426	(not collected)
Albums	805,930	805,930	(not collected)

Breaking SA: determined attacker

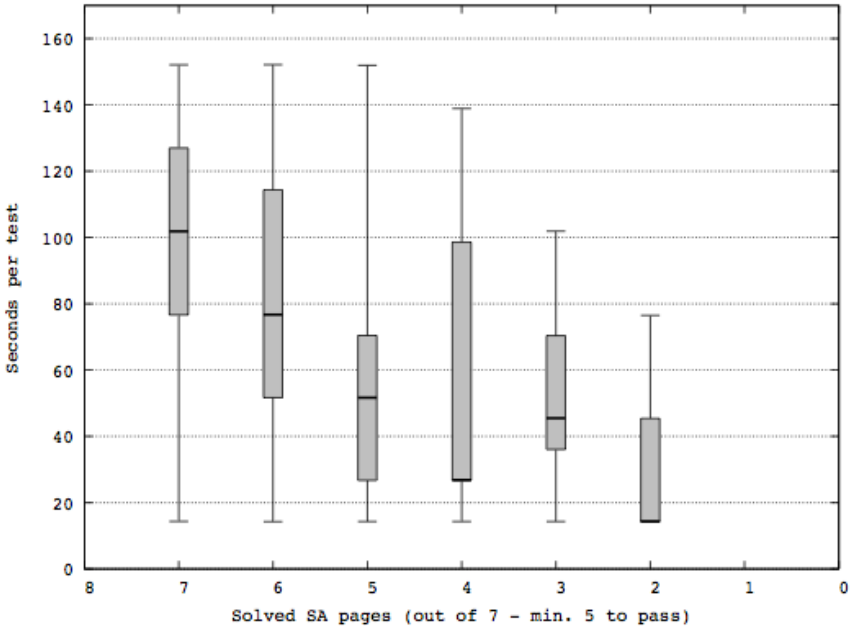
- Attacker has access to “all the photos”
- Selected users with enough photos as friends
- Extract faces from photos

- Train our system with K = 10, 20, .., 120 faces per friend
- Simulated SA tests from public photos
- Generate 30 simulated SA tests from photos not used for training

Breaking SA: determined attacker



Successfully passed pages as a function of the training set.

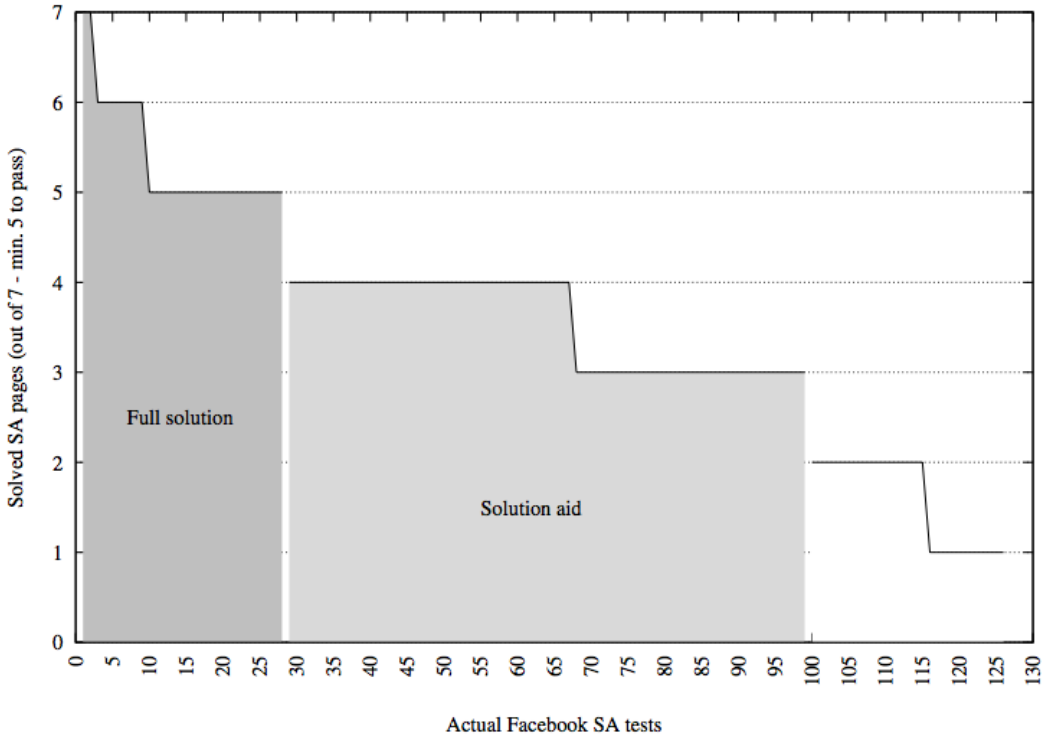


Time required to lookup photos as a function of solved pages.

Breaking SA: casual attacker

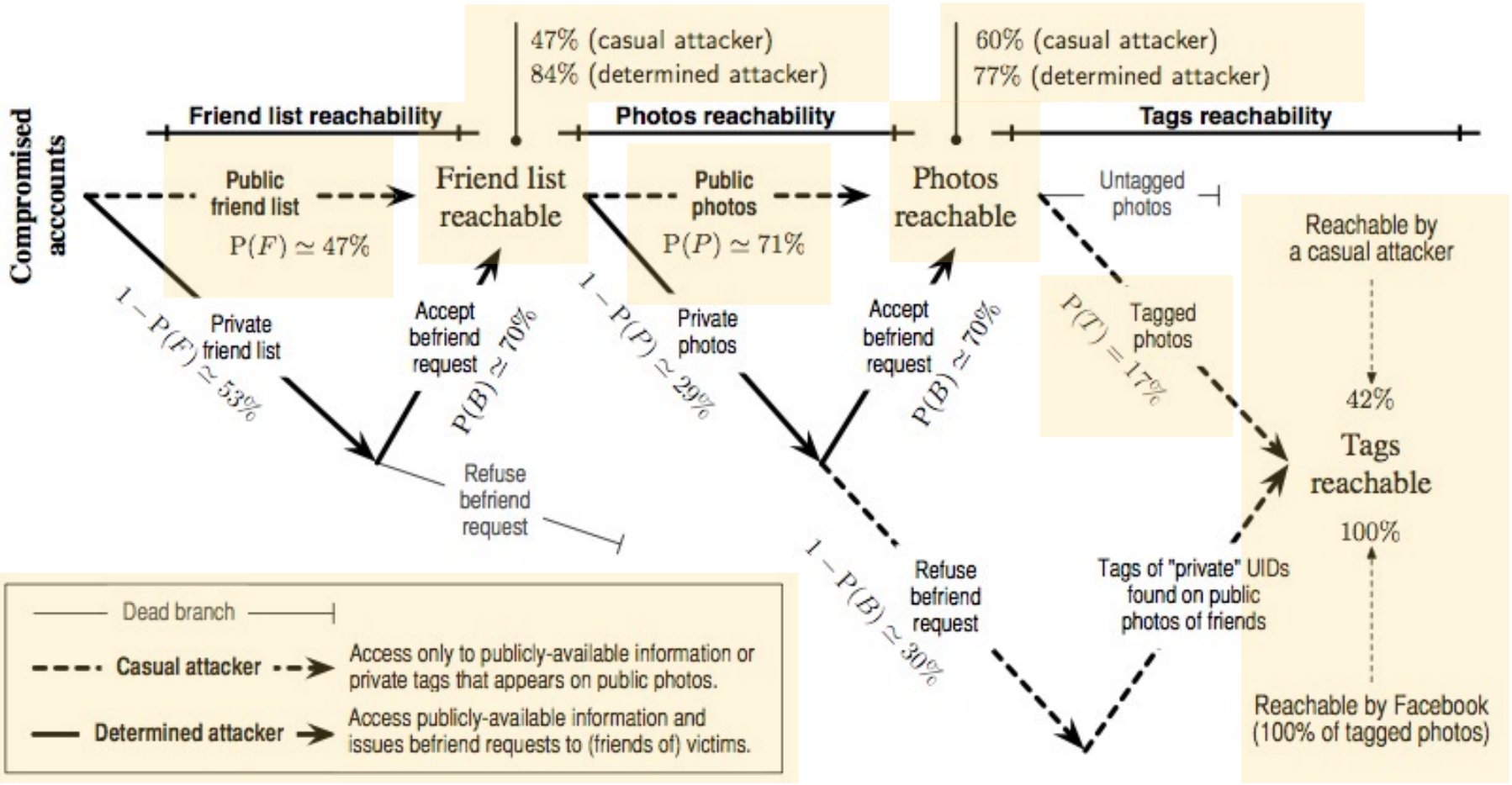
- Use our dummy accounts as “victims”
- Automated SA triggering through ToR
- Collect snapshot of 127 real SA tests
  - Manually answered the CAPTCHA
- Use face.com to break the tests (challenging conditions)
- ~44 seconds to solve a complete test

Breaking SA: casual attacker



- Manual verification
  - 22% solved
  - 56% need 1-2 guesses
- Failed photos
  - 25% no face in photo
  - 50% unrecogn. face
  - 25% no model available

Attack Surface Estimation



Remediation Measures

- Facebook features (opt-in)
  - Login Approval (SMS based) – traditional 2 factor auth.
- Slowing down the attacker
  - Remove suggestions
  - Reduce time window
- Revisit SA
  - Select photos that contain faces software can't identify

Facebook's Response

- Acknowledged our results
- "Deployed SA to raise the bar in large-scale phishing attacks"
- "Not designed for small-scale or targeted attacks"
- "Users can enable Login Approval"
  - How many have actually done so?

Discussion

- Eurograbber malware [1]
  - Targets EU banks
  - Infects user's computer
  - Tricks user into installing smartphone malware via bogus messages and social engineering
  - Intercepts 2nd factor token sent to user's device
- What are the implications of using the same device as the 2nd factor, and for browsing?
- SA security compared to traditional two-factor with smartphones?

[1] https://www.checkpoint.com/products/downloads/whitepapers/Eurograbber_White_Paper.pdf

Conclusions

- Designed and implemented an automated SA breaking system
- Demonstrated the weaknesses of SA
- Publicly-available data sufficient for attackers
- Cloud services can be utilized effectively

- Facebook should reconsider its threat model
- Need to revisit the SA approach

Thank you!

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