RUHR-UNIVERSITÄT BOCHUM

"Someone Definitely Used 0000": Strategies, Performance, and User Perception of Novice Smartphone-Unlock PIN-Guessers

Daniel V. Bailey, Collins W. Munyendo, Hunter A. Dyer, Miles Grant, Philipp Markert, Adam J. Aviv

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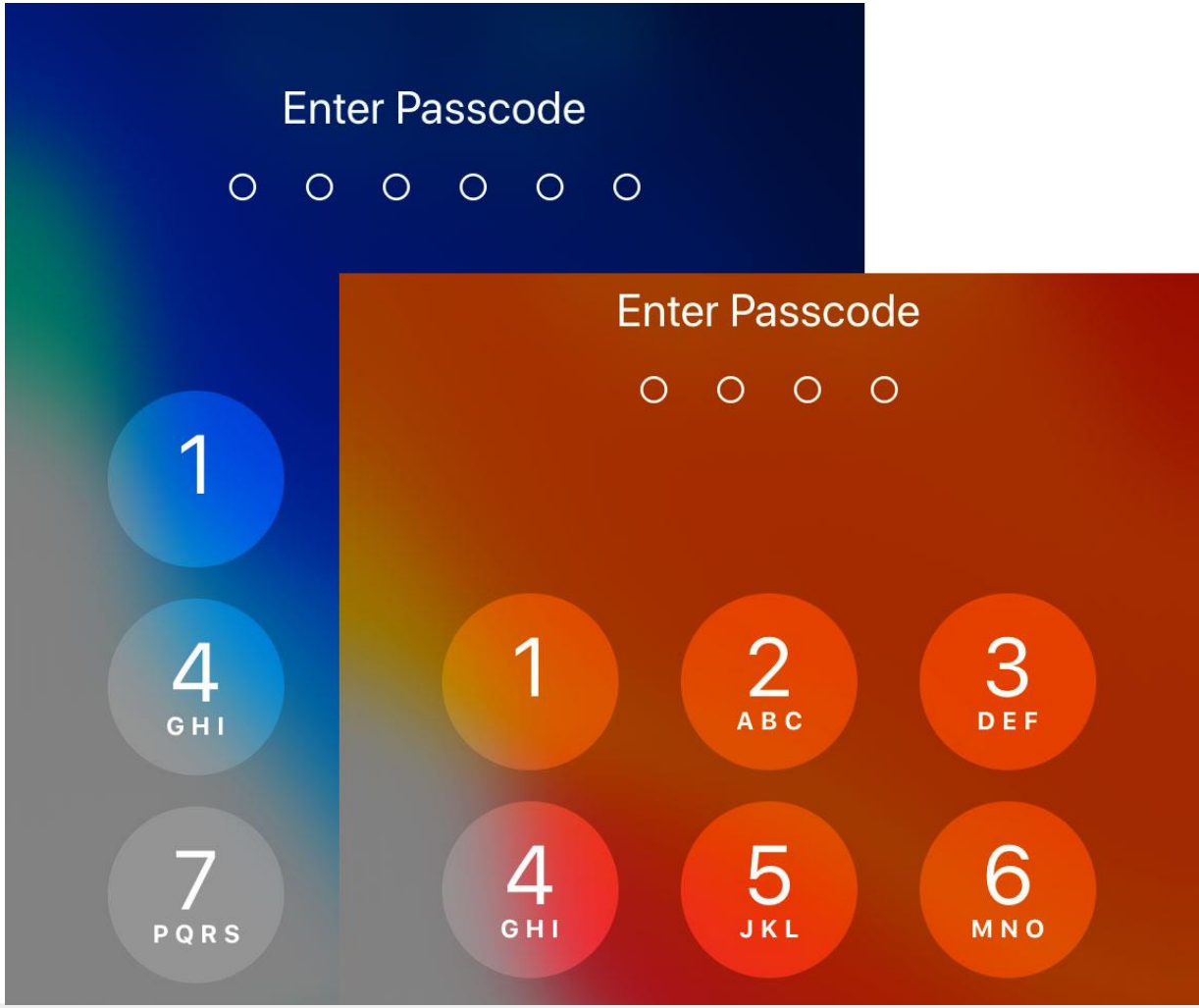
User Authentication

Decades of research on authentication and still we struggle with the same issues around **security** and **usability**. [1]

Knowledge-Based Authentication (KBA)



[Ref. 1] Herley et al.: **Passwords: If We're So Smart, Why are We Still Using Them?** (FC 2009)

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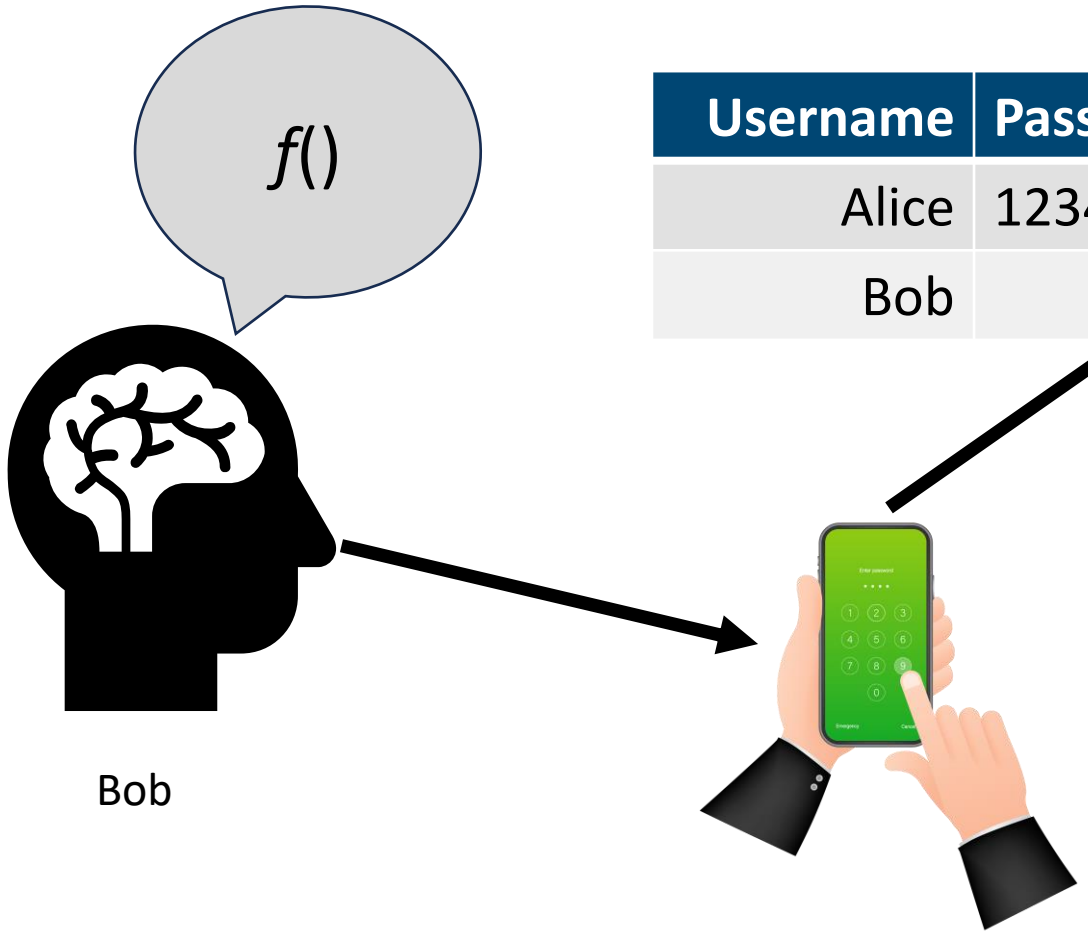
Basic Setup: User-Chosen KBA Research



Username	Password
Alice	123456
Bob	

We don’t know *f*()! What can we do?

Define setting for *f*()

↓

Find new dataset like *f*()

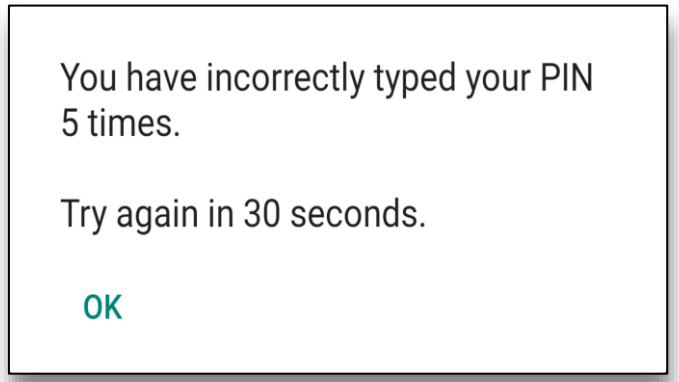
↓

Make new guessing heuristic

↓

Compare against previous heuristics

Focus on Throttled Attacker



No side channels!

Mobile guesser has a
- limited number of attempts

Guesses	Android	iOS
10	30sec	1h 36m
100	10h 45min	-

Attacker is *trawling*
- No personal info about target
- Attacker happy to unlock anyone's device

Example: Phones sold at US police auctions [2]

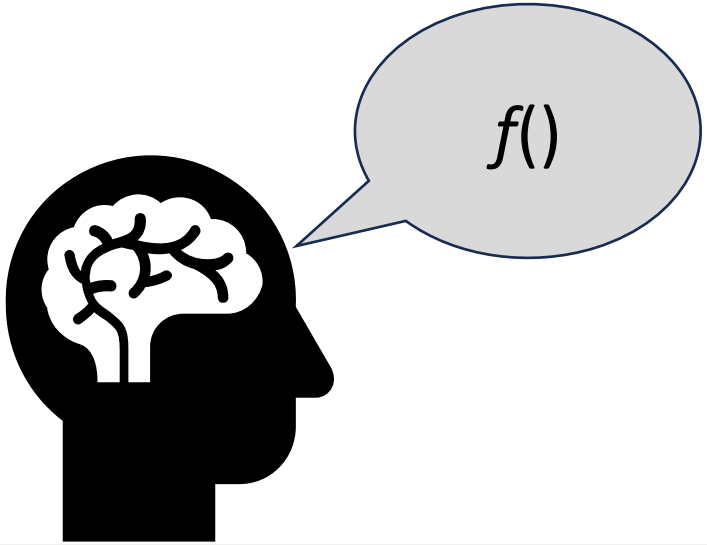
[Ref. 2] Roberts et al.: "**Blue Is the New Black (Market): Privacy Leaks and Re-Victimization from Police-Auctioned Cellphones**" (IEEE S&P '23)

KBA Research Basic Methodology

Previous proxy: Digits from password leaks [3]

- 6-digit PINs from alphanumeric passwords
- 4-digit PINs from Amitay's
  - "Big Brother Camera Security" iOS app

Count	Password
1 044 164	123456
176 120	password
88 076	12345678
78 720	111111



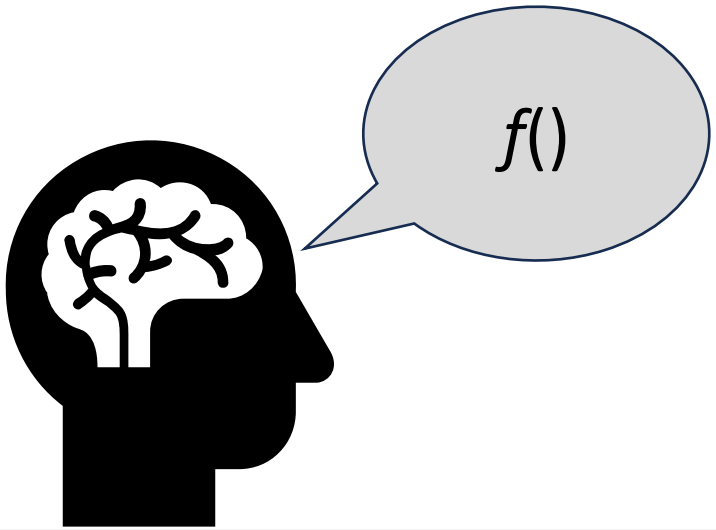
[Ref. 3] Markert et al.: "**On the Security of Smartphone Unlock** PINs" (ACM TOPS '21)

What About “Real” Attackers?

Do the previous datasets model a real-world threat?

PIN-guessing is something of a “target of opportunity”

A lost/stolen/unattended phone



Define setting for *f*()

↓

Find new dataset like *f*()

↓

Make new guessing heuristic

↓

Contribution: New “proxy” dataset from users playing the attacker

↓

Compare against previous heuristics

Novice Guesser Research Questions

RQ1: How do novices guess?

RQ2: How do they compare to prior datasets?

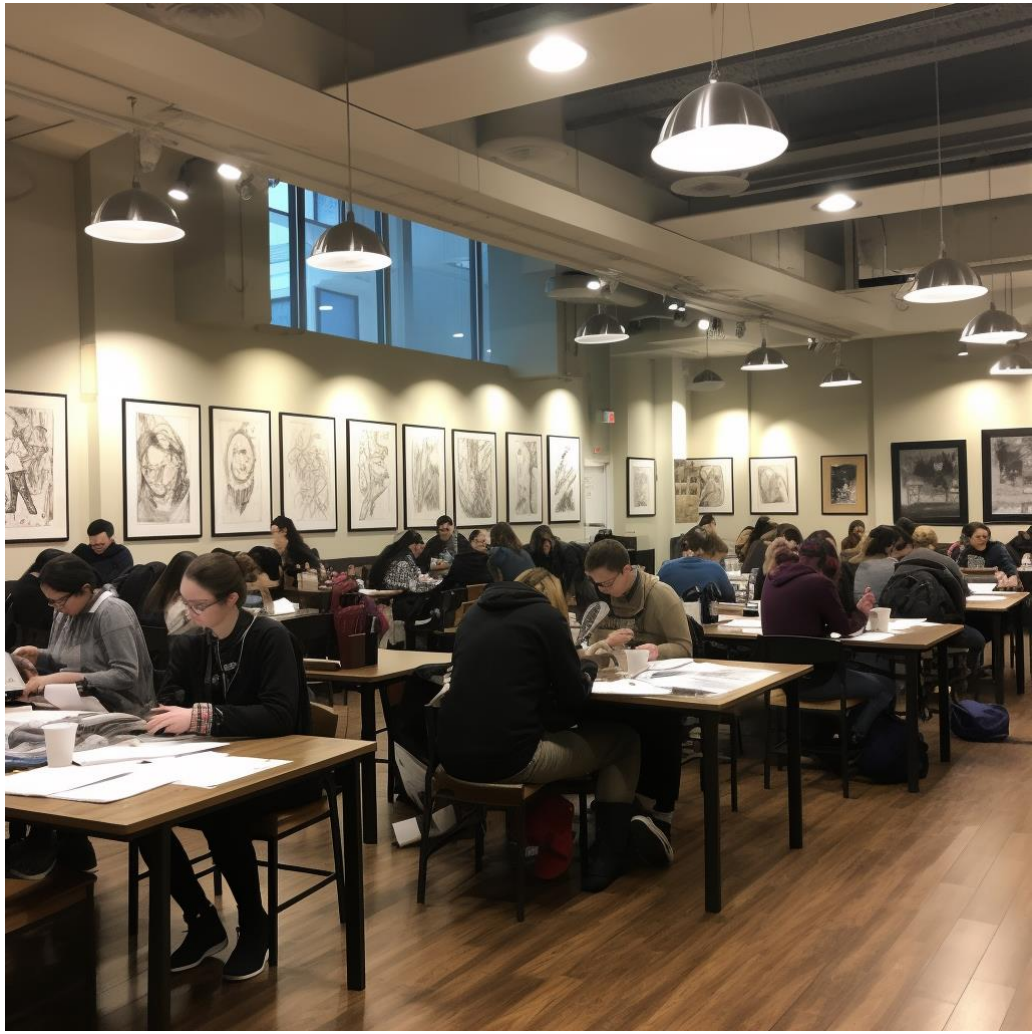
RQ3: What scenarios are they concerned about?

User Study Overview

Inspired by Uellenbeck, et al.[4]

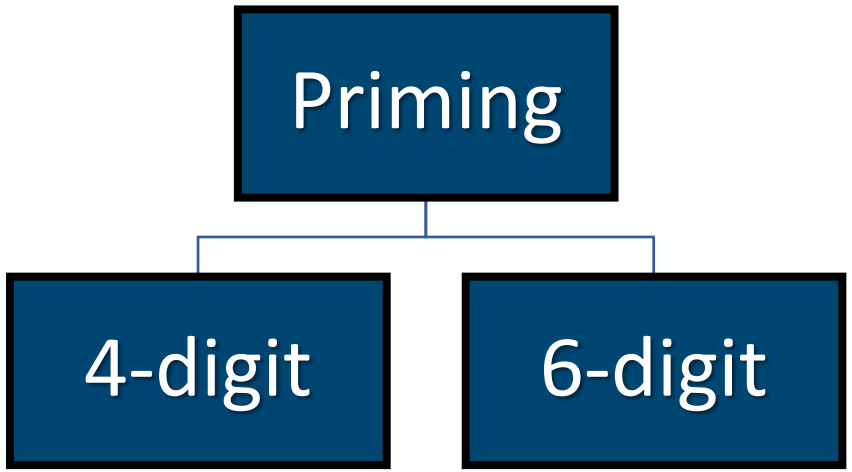
Our version:

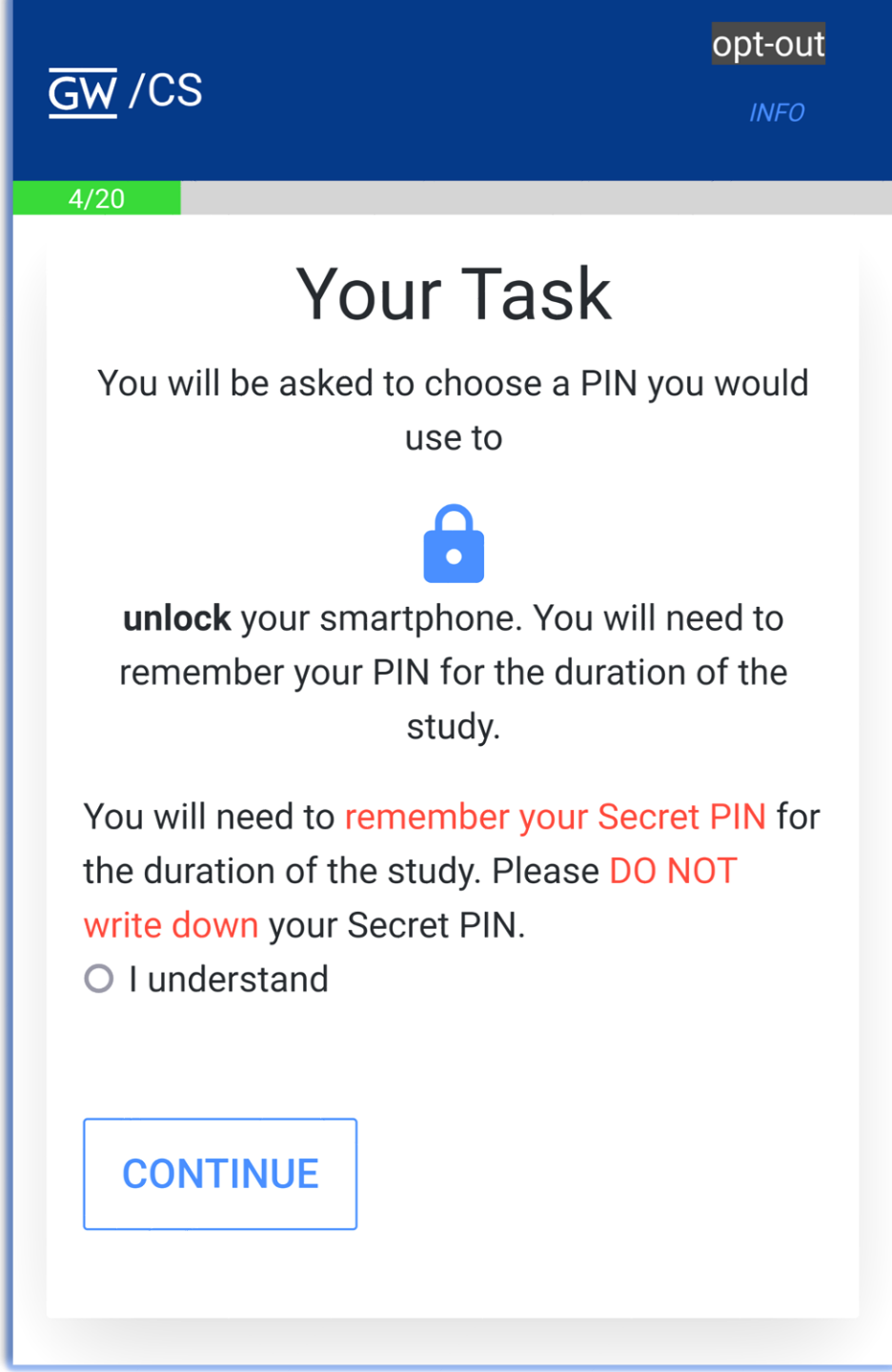
- Online (*n* = 210)
- Pick a “secret” PIN
- 5 guesses → Get a cash bonus for success



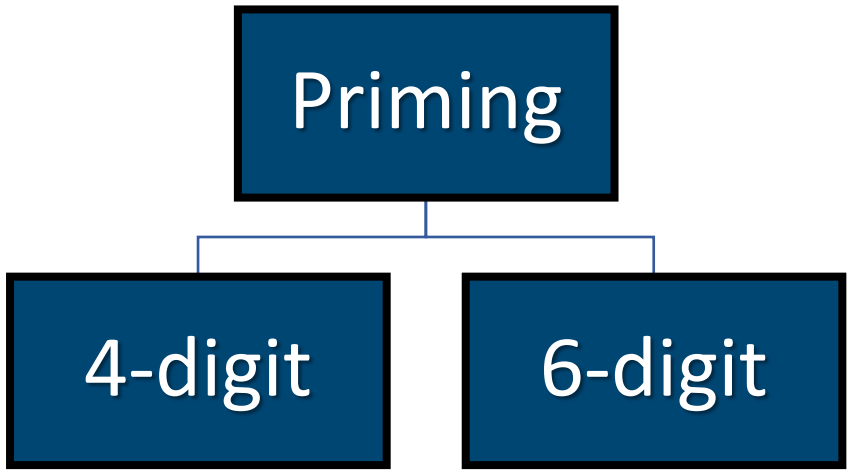
[Ref. 4] Uellenbeck, et al.: **“Quantifying the Security of Graphical Passwords: the Case of Android Unlock Patterns”**: (ACM CCS ’13)

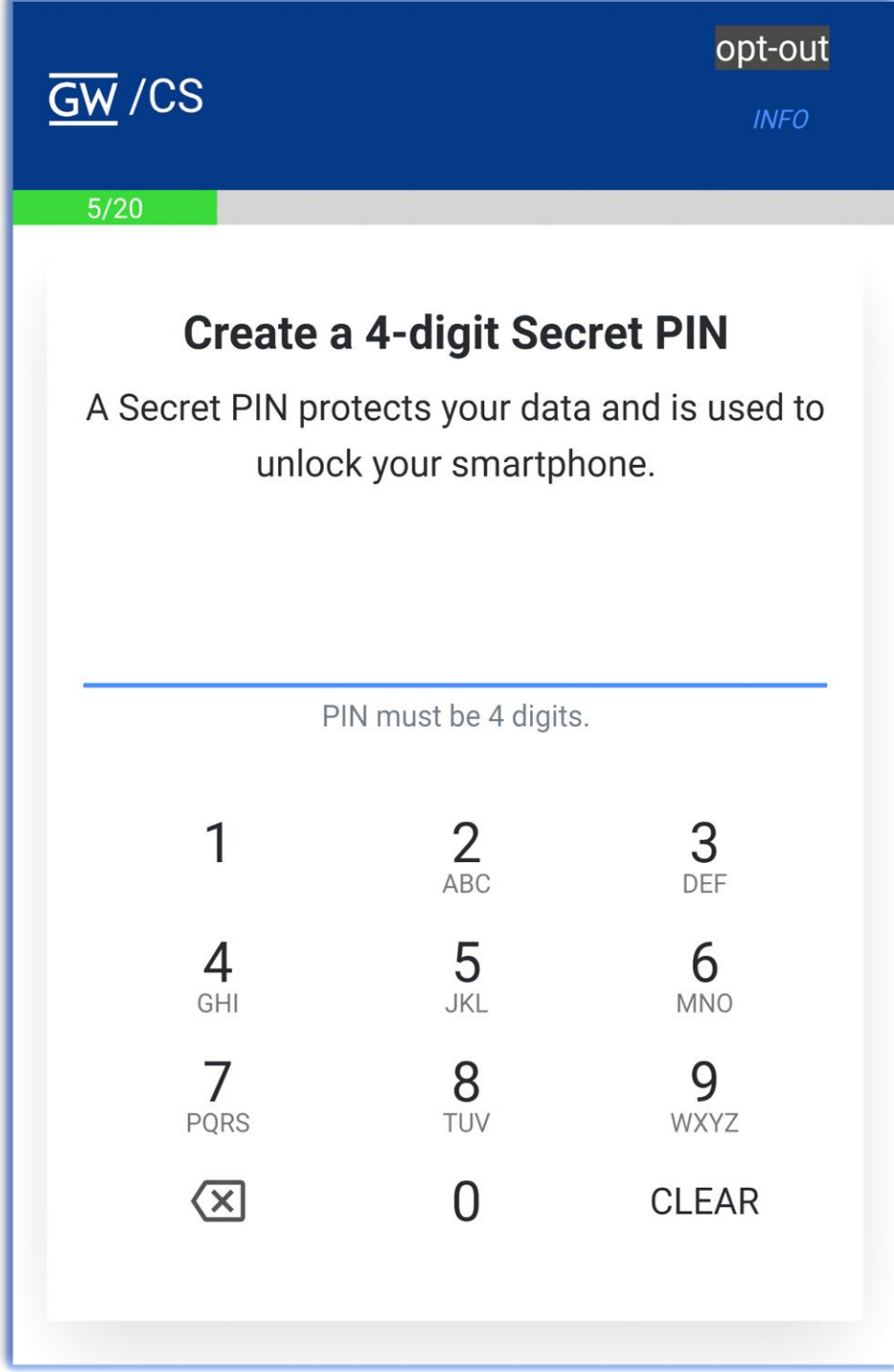
Methodology: User Study (*n* = 210)



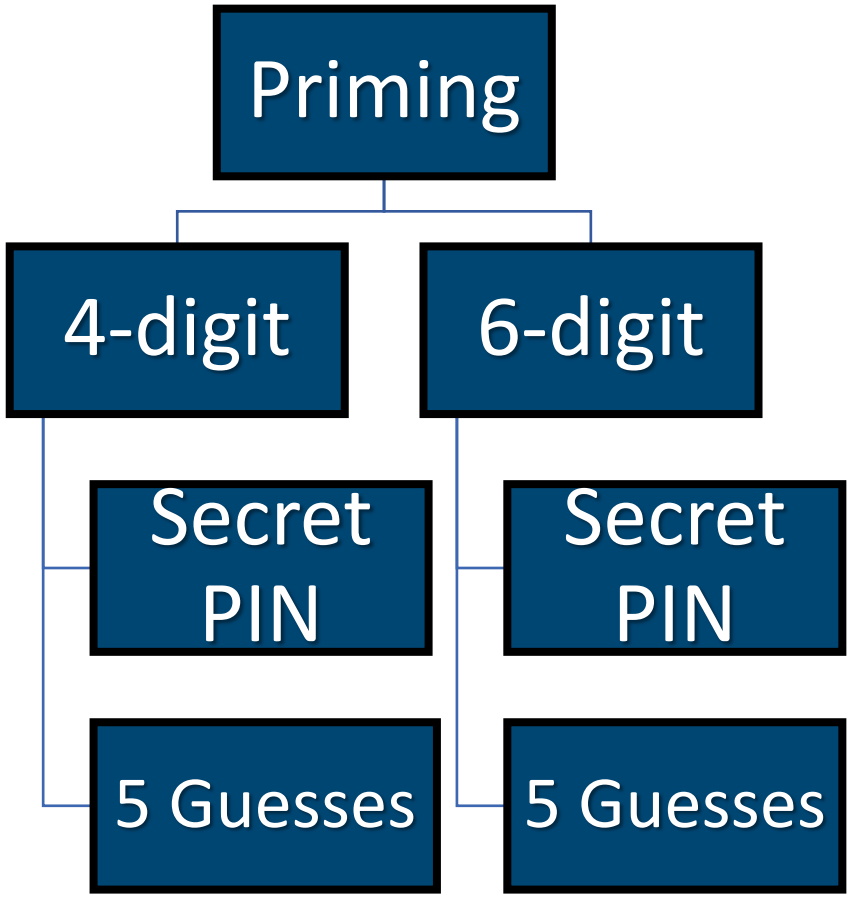


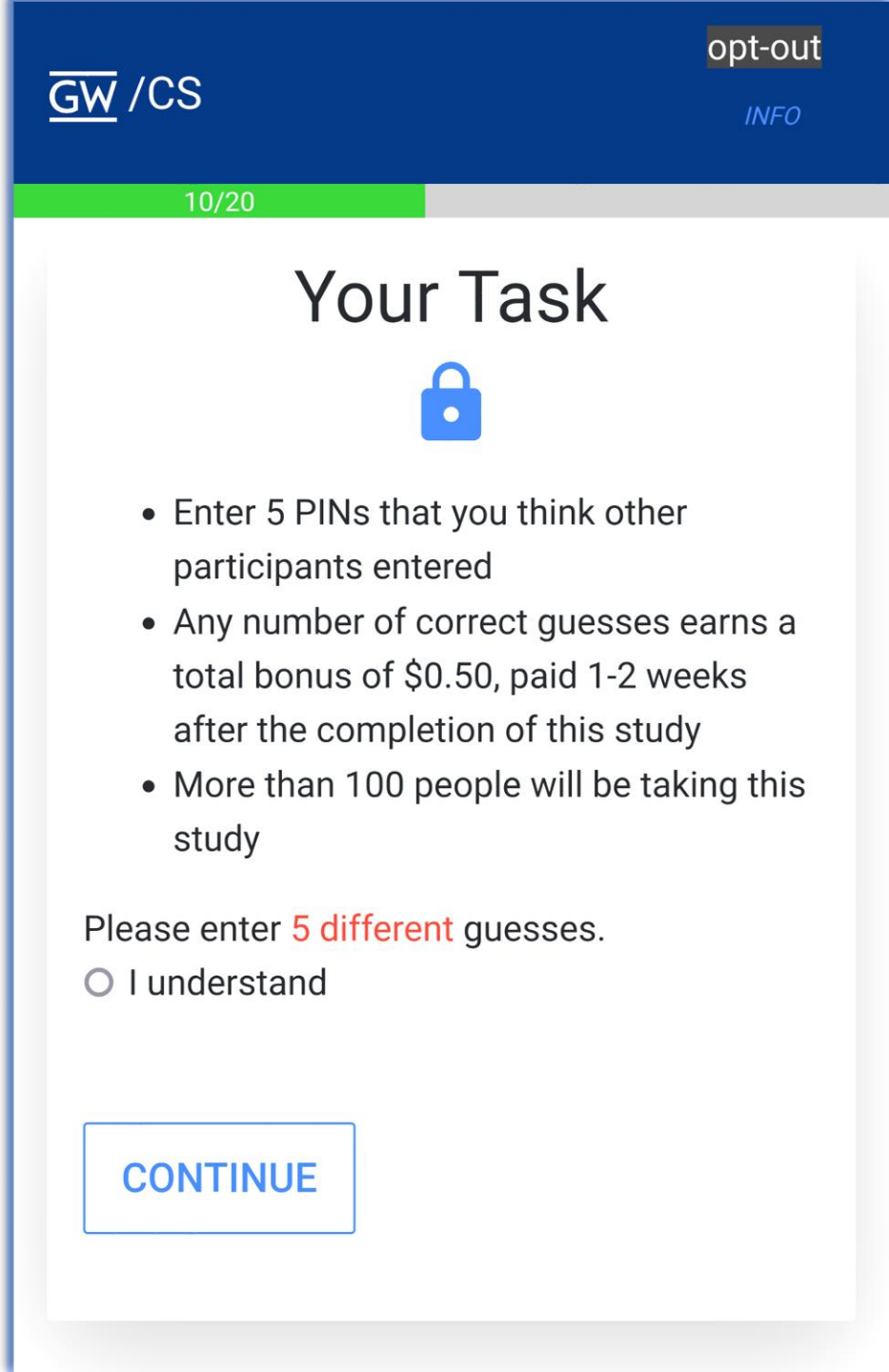
Methodology: User Study (*n* = 210)





Methodology: User Study (*n* = 210)





RQ1: How do Novices Guess?

Guessing risk concentrated in a small handful of PINs, like **0000**

- Only one-third thought their PIN would be guessed
- PINs in **bold** were guessed by 20+ attackers

Other popular guesses that were incorrect:

1111, 000000, 111111, 987654

85% of participants guessed successfully

10% of secret PINs were guessed

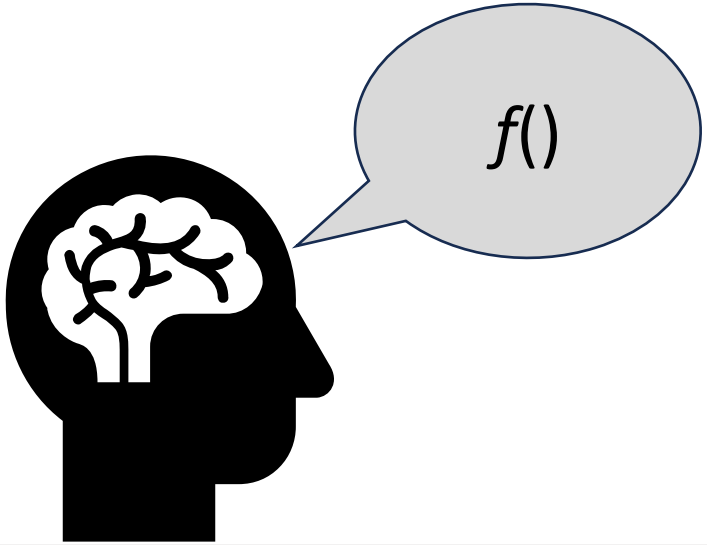
4d Guessed	6d Guessed
0000	121212
1234	**123456**
1478	134679
1990	135790
1995	159753
1997	654321
2000	
2468	
2580	
6666	

RQ2: Comparison Against Prior Datasets

What if we built an aggregate or data-driven guesser from our new list?

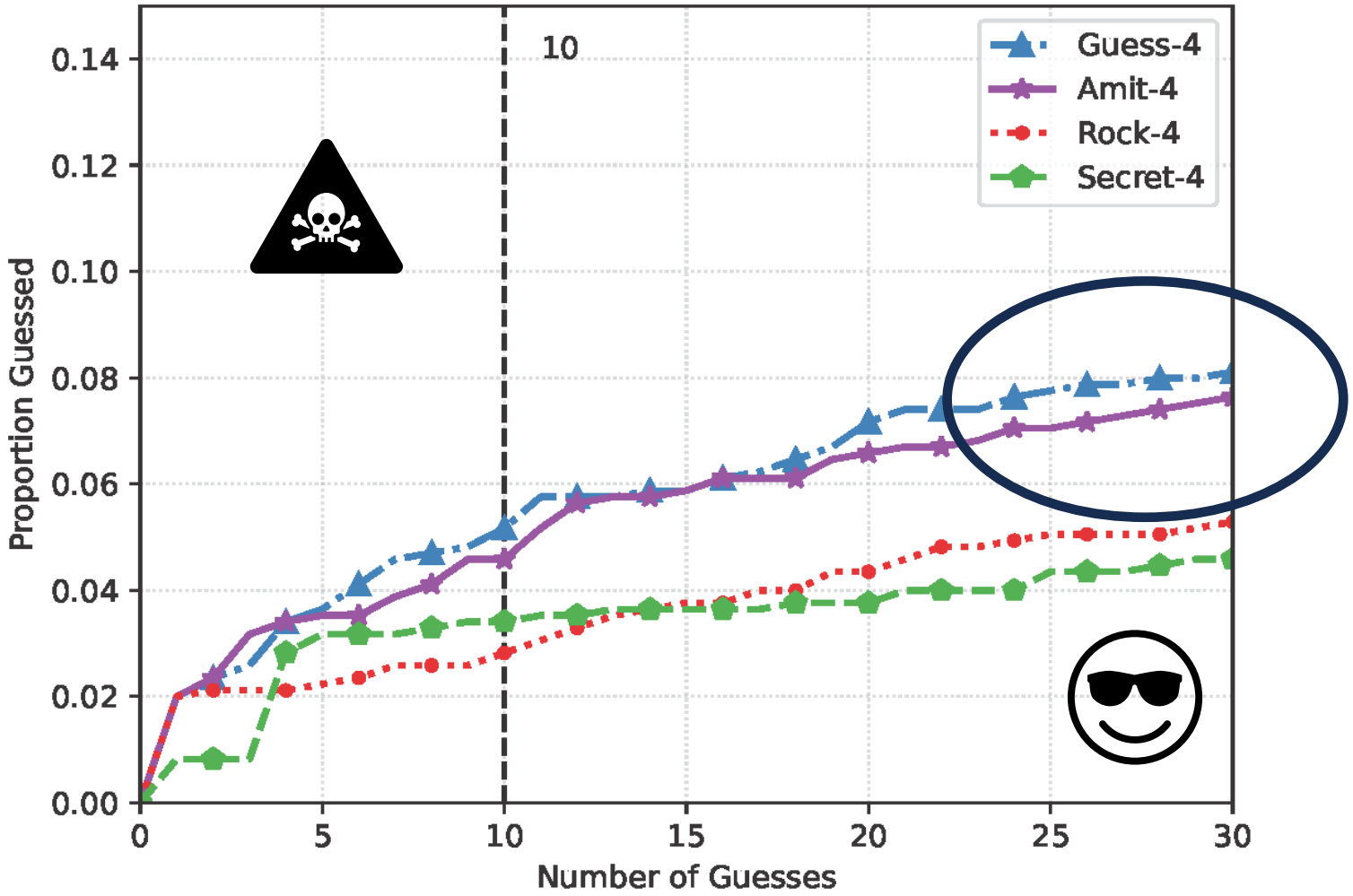
How would it compare?

Count	Password
1 044 164	123456
176 120	password
88 076	12345678
78 720	111111

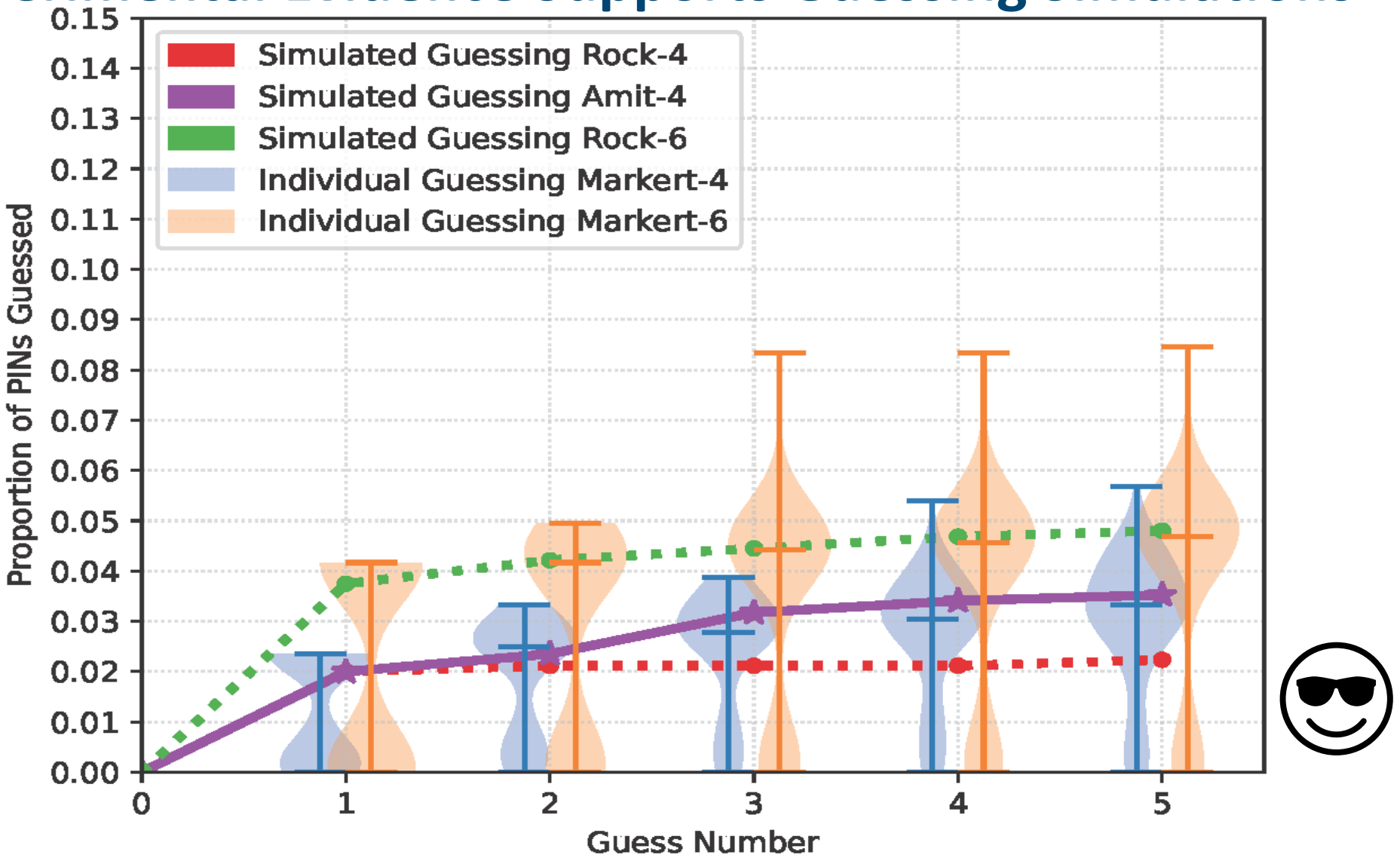


RQ2: How do They Compare with Prior Datasets?

4-digit/30 guesses: 8.1% observed vs. 7.6% simulated



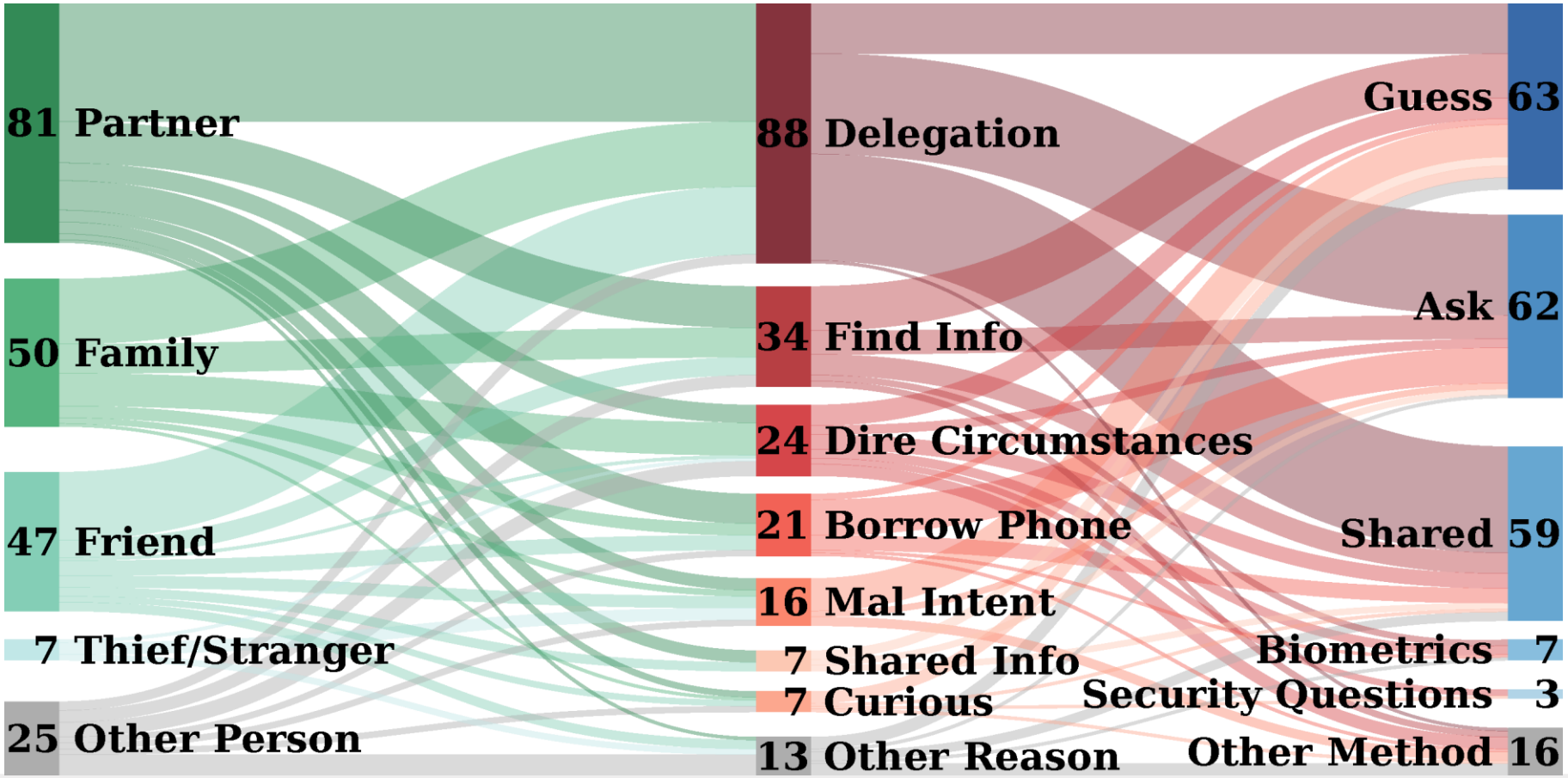
RQ2: Experimental Evidence Supports Guessing Simulations



RQ3: What Scenarios are Participants Concerned About?

Participants mostly think about close social contacts

Future work: guessing by insiders!!



Novice Guesser Research Questions: Results

RQ1: Performance of novice guessers

- 10% (21) participants' PINs were guessed
- 4-digit: 13%
- 6-digit: 7%
- …at 30 guesses

RQ2: Prior dataset comparison

- New dataset
- Comparable to prior sets

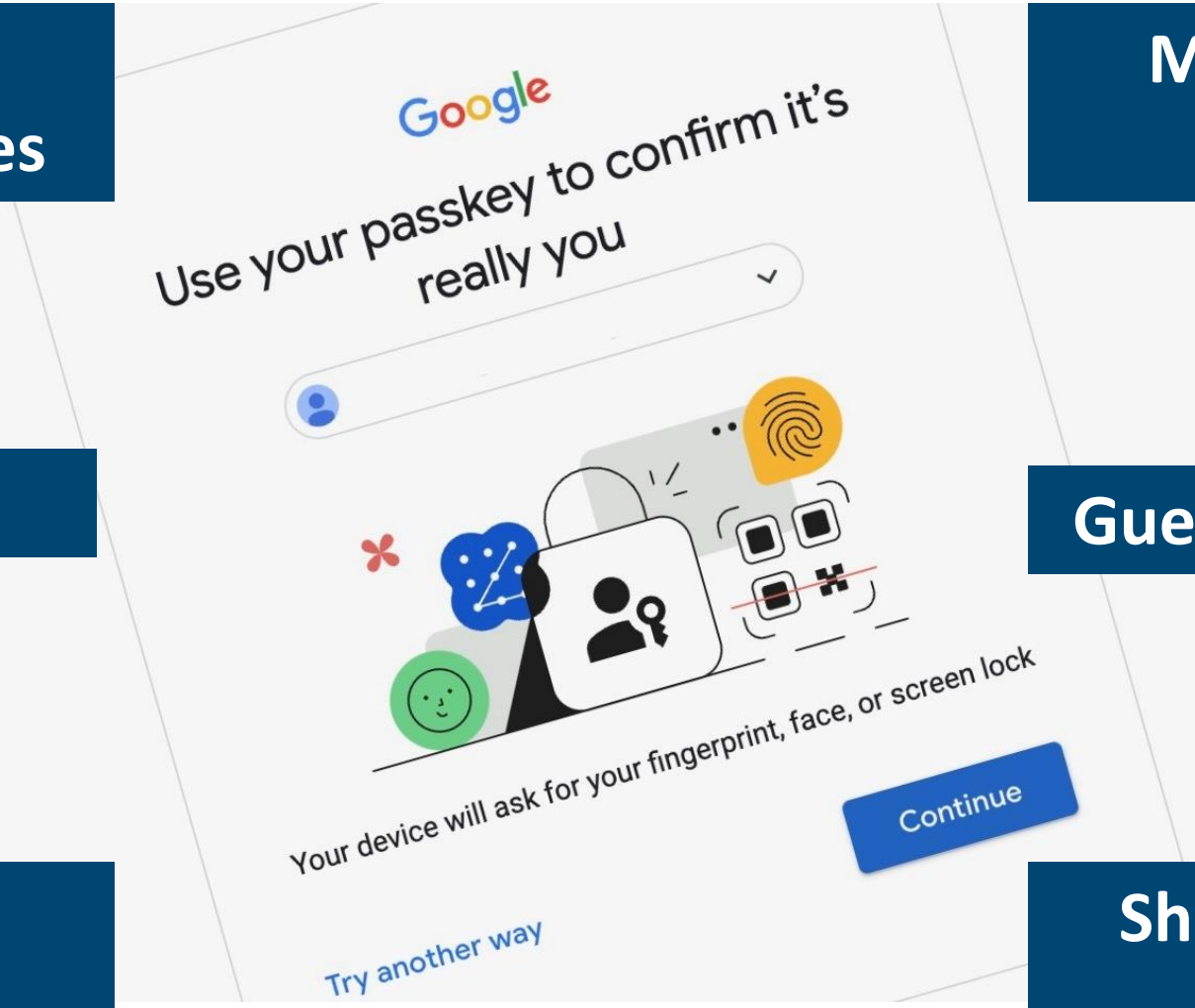
RQ3: Areas of concern

- Close social connections
- 37% attempted access
- 45% changed their PIN *to keep someone out*

Outlook/Future Work

Better messaging/nudges

More local KBA validation



Side channels

Guessing by insiders

Special populations

Sharing/revoking access

Takeaways

Define setting for *f*()

↓

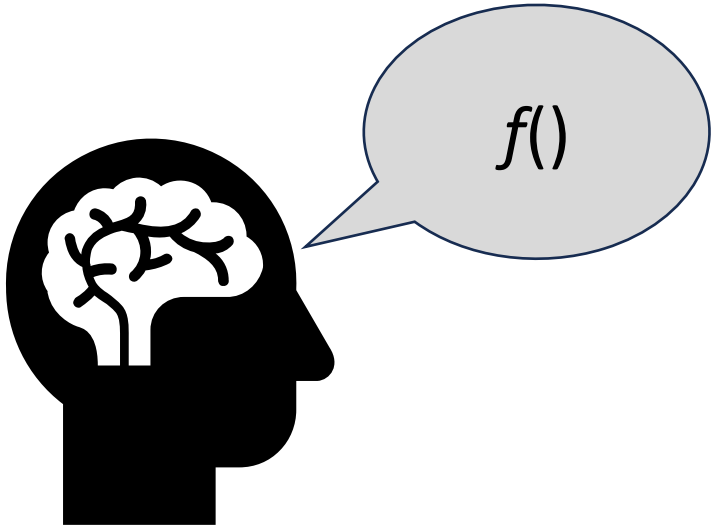
Find new dataset like *f*()

↓

Make new guessing heuristic

↓

Compare against previous heuristics



Throttling protects all but ~10% of PINs

4- and 6-digit PINs about the same

Unauthorized access is commonplace

Email: daniel.bailey@rub.de
Twitter: @pinresearcher