RUHR UNIVERSITÄT BOCHUM

RUB

Max Planck Institute for Security and Privacy

THE GEORGE WASHINGTON UNIVERSITY

WASHINGTON, DC

GW

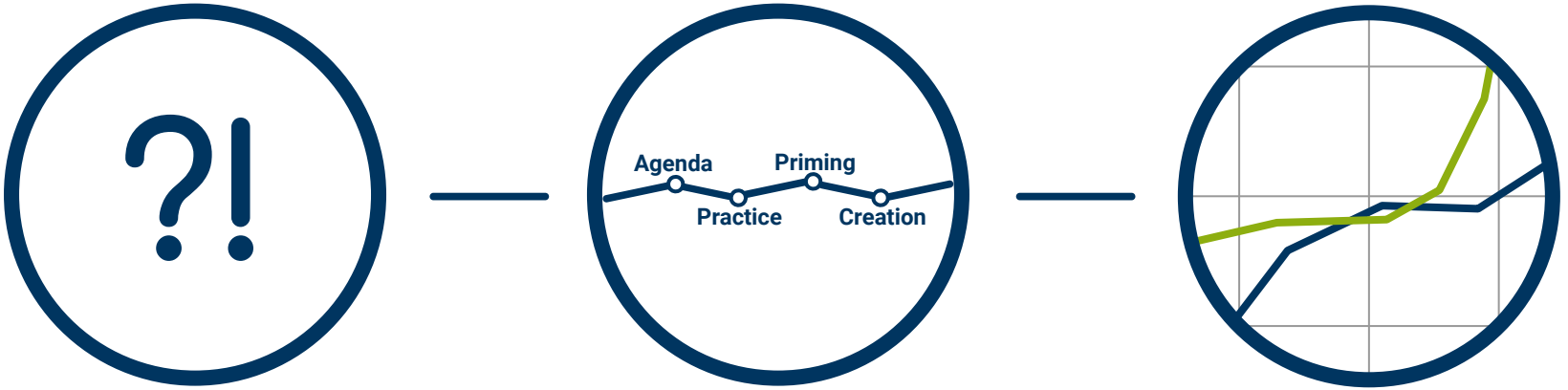
This PIN Can Be Easily Guessed

Analyzing the Security of Smartphone Unlock PINs

Philipp Markert, Daniel V. Bailey, Maximilian Golla, Markus Dürmuth, and Adam J. Aviv

May 18, 2020 | 41st IEEE Symposium on Security and Privacy

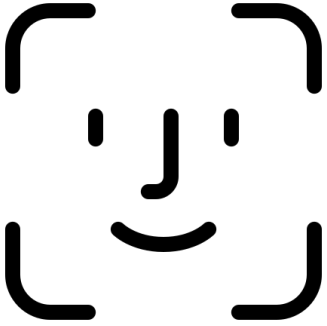
Overview



Why study PINs? — User Study — Results

Why PINs?

Fingerprint



Face

PHOTO: Dan Seifert | The Verge (Vox Media)

Iris

Who uses PINs?

1220 participants

461 do not use a biometric

759 use a biometric

210 use a PIN

595 use a PIN

Overall 805 (66%) use a PIN

What we know about PINs

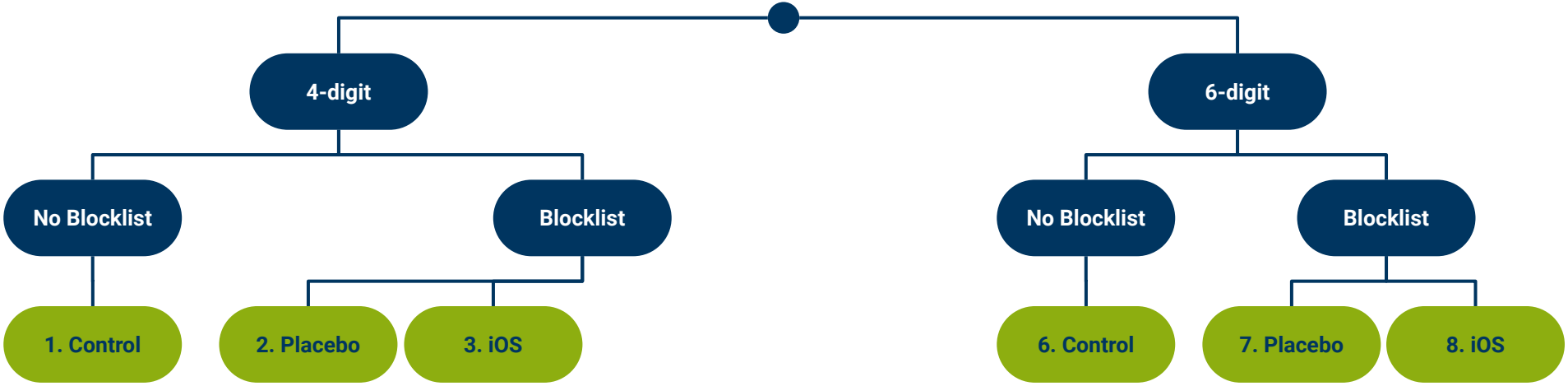
- User chosen 4-digit PINs are predictable [1]
- User chosen 6-digit PINs aren't any better [2]
- Blocking popular PINs can increase security [1]

What we don't know

- How secure are 4- or 6-digit PINs in the smartphone unlock setting?
- What are the effects of different blocklists on the security of PINs?
- How to balance security and usability when composing a blocklist?

[1] J. Bonneau, S. Preibusch, and R. Anderson. **A Birthday Present Every Eleven Wallets?** The Security of Customer-Chosen Banking PINs. FC '12
[2] D. Wang, Q. Gu, X. Huang, and P. Wang. **Understanding Human-Chosen PINs**: Characteristics, Distribution and Security. AsiaCCS '17

Treatments



Placebo

"Test general effect of warning"

Blocklist:

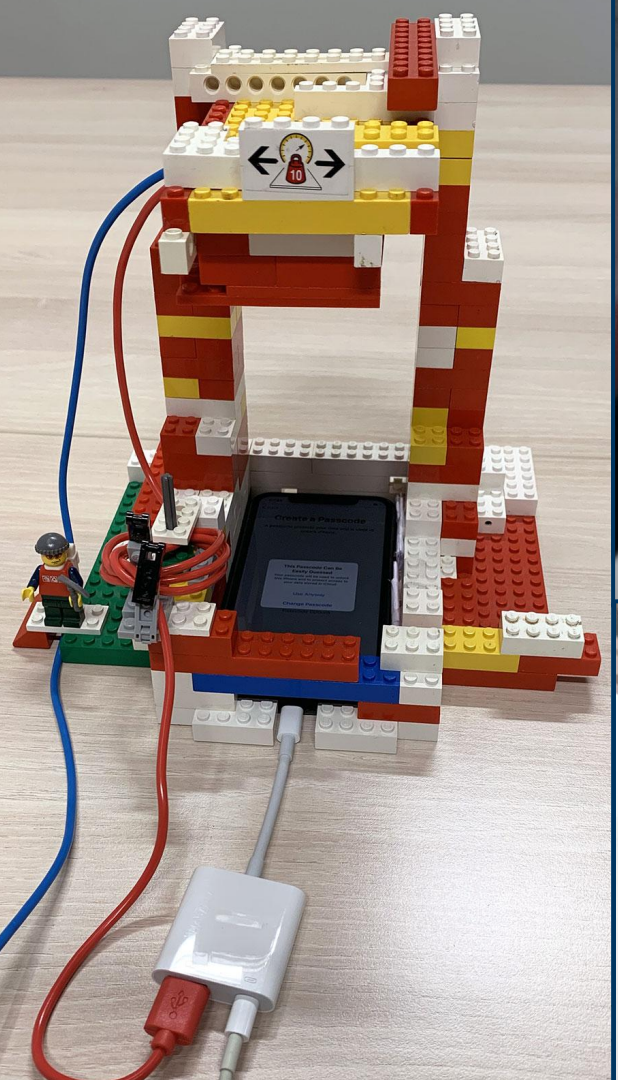
- "1st choice" blocked
- Any other PIN allowed

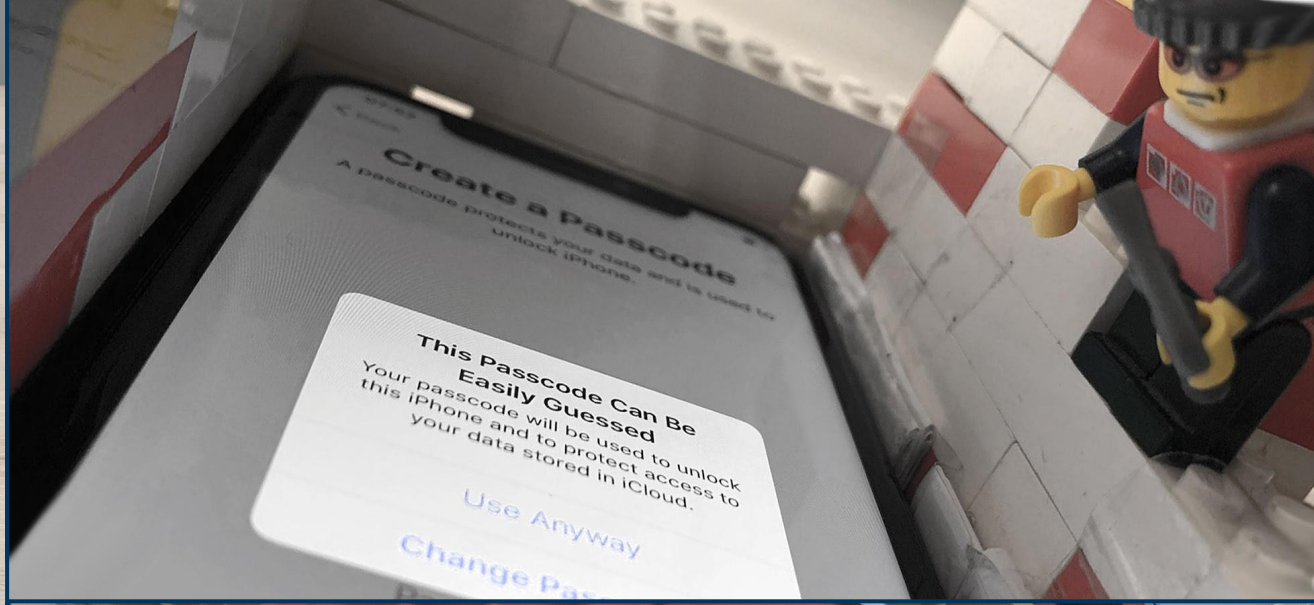
iOS

"Test effect of iOS blocklists"

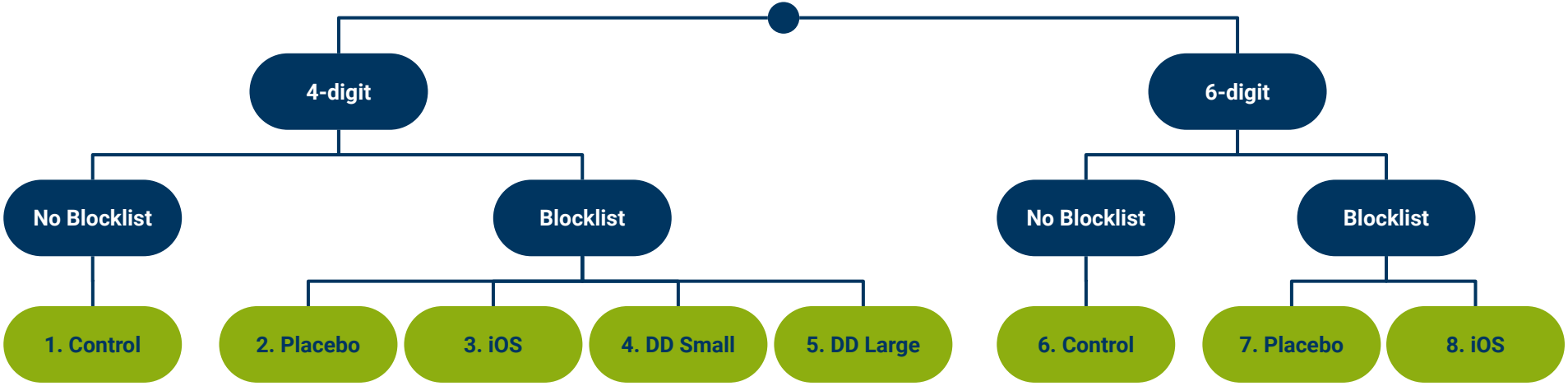
Blocklist:

- 274 PINs (4-digit)
- 2910 PINs (6-digit)




Create a Passcode
A passcode protects your data and is used to
unlock iPhone.
This Passcode Can Be
Easily Guessed
Your passcode will be used to unlock
this iPhone and to protect access to
your data stored in iCloud.
Use Anyway

Treatments



Placebo

"Test general effect of warning"

Blocklist:

- "1st choice" blocked
- Any other PIN allowed

iOS

"Test effect of iOS blocklists"

Blocklist:

- 274 PINs (4-digit)
- 2910 PINs (6-digit)

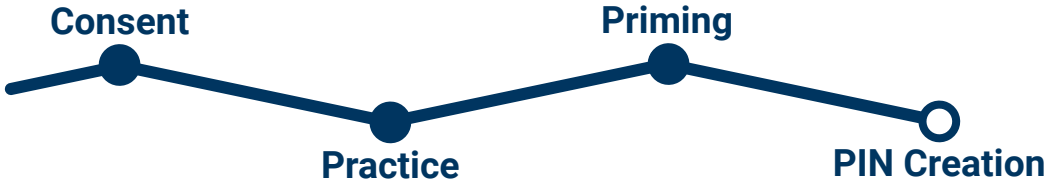
Data-Driven (DD)

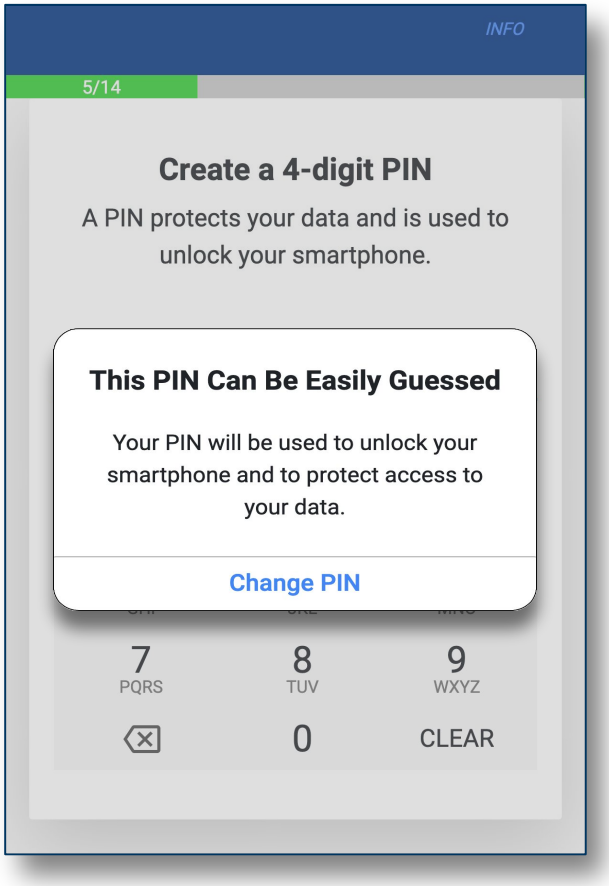
"Test effect of different blocklist sizes"

Blocklist:

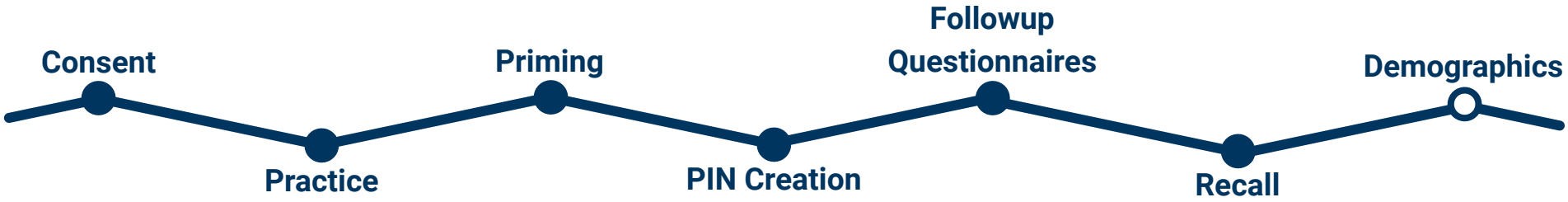
- Top 27 PINs of Amitay (small)
- Top 2740 PINs of Amitay (large)

User Study


Consent
Practice
Priming
PIN Creation

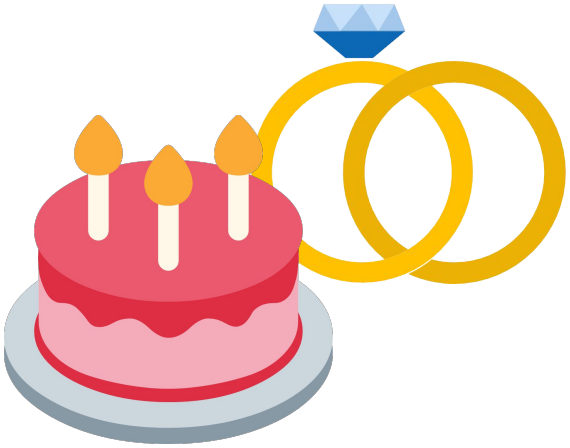

INFO
5/14
Create a 4-digit PIN
A PIN protects your data and is used to unlock your smartphone.
This PIN Can Be Easily Guessed
Your PIN will be used to unlock your smartphone and to protect access to your data.
Change PIN
7 PQRS
8 TUV
9 WXYZ
0
CLEAR

User Study


Consent
Practice
Priming
PIN Creation
Followup Questionnaires
Recall
Demographics

Attacker Model

- No information about the victim



Attacker Model

- No information about the victim

- Guesses PINs in decreasing probability order

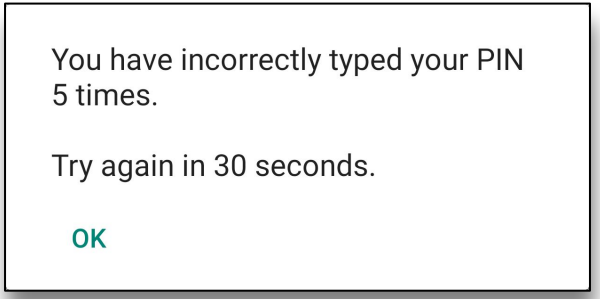
Rank	4-digit PINs	6-digit PINs
1	1234	123456
2	0000	123123
3	2580	111111
⋮	⋮	⋮

Attacker Model

- No information about the victim

- Guesses PINs in decreasing probability order

- Slowed down by rate-limiting



	Android	iOS
10 Guesses	30s	1h 36m 0s
100 Guesses	10h 45min 30s	—

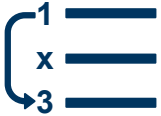
Attacker Model

- No information about the victim

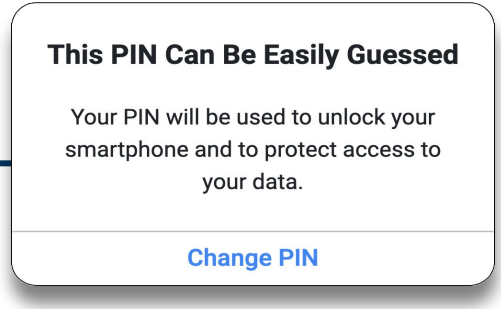
- Guesses PINs in decreasing probability order

- Slowed down by rate-limiting

Rank	4-digit PINs	6-digit PINs
1	1234	123456
2	~~0000~~ not allowed	
3	2580	
⋮	⋮	



- Knows the blocklist and skips impossible choices



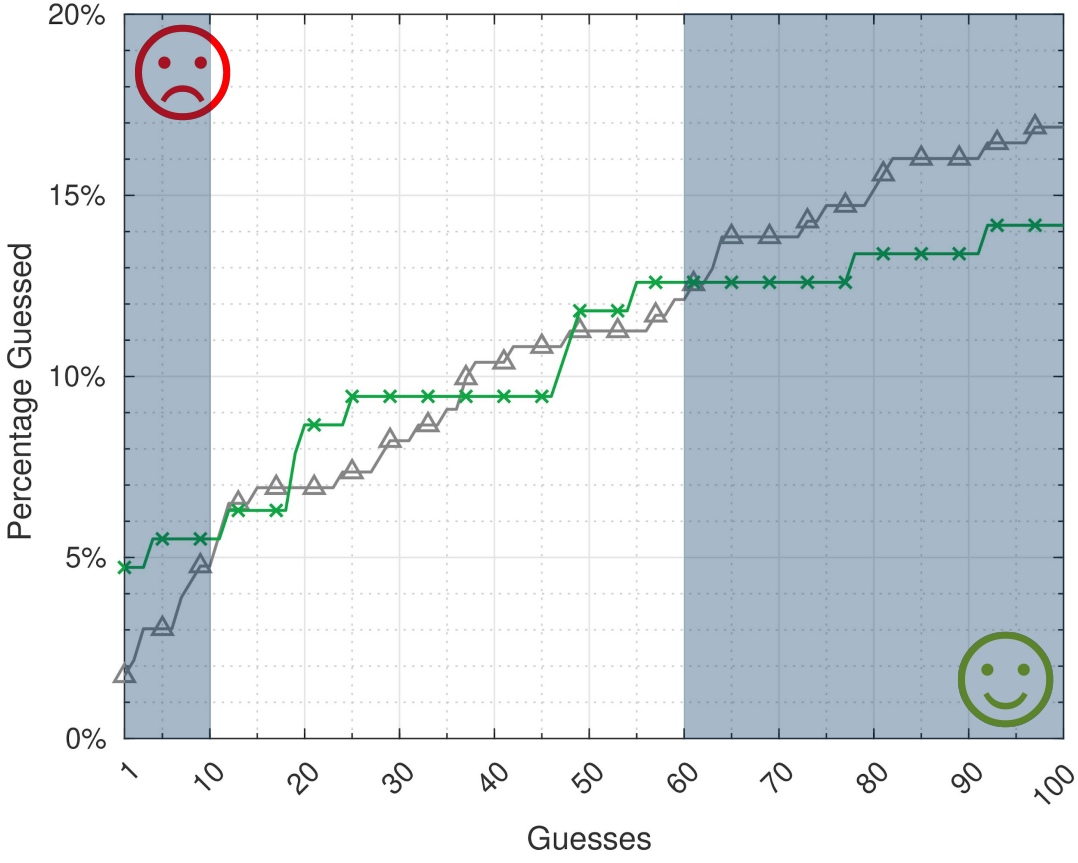
Research Questions

RQ1: How secure are 4- and 6-digit PINs in the smartphone unlock setting?

RQ2: What are the effects of different blocklists on the security of PINs?

RQ3: How to balance security and usability when composing a blocklist?

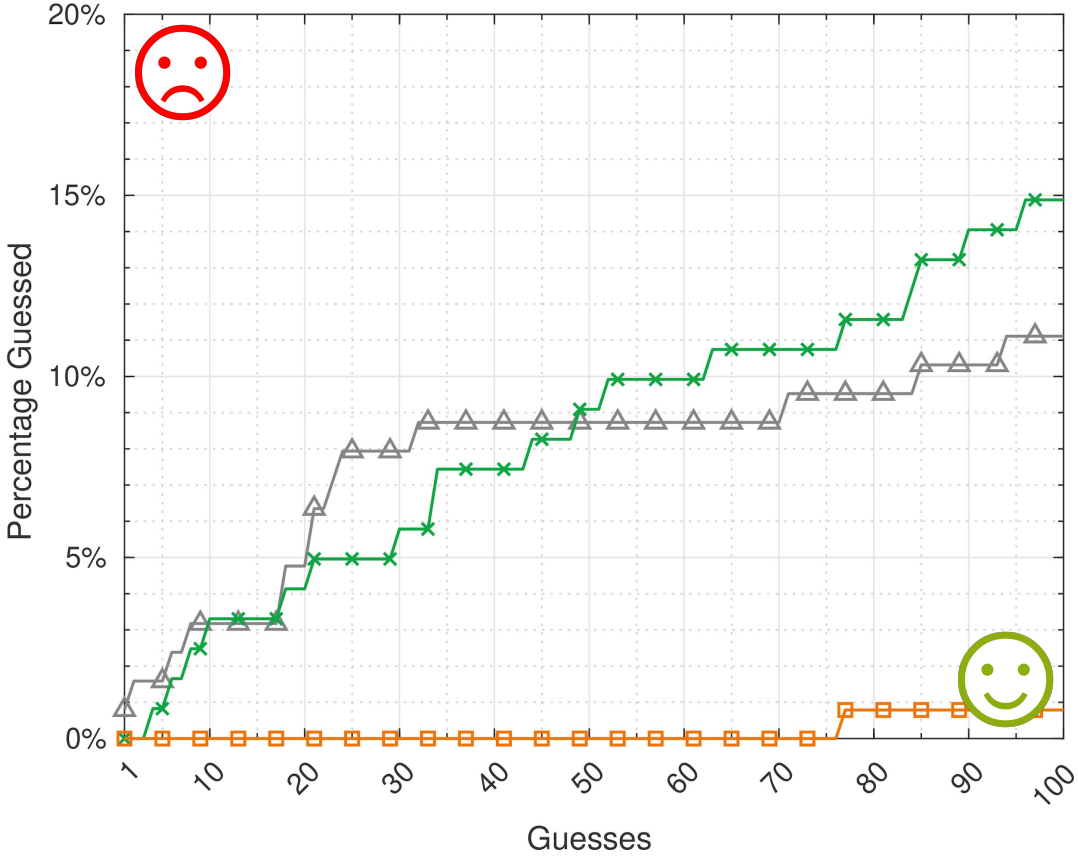
RQ1: 4- vs. 6-digit PINs



Observations:

- Overall comparable security of 4- and 6-digit PINs in the defined attacker model
- Differences depending on the number of guesses

RQ2: Different Blocklist Sizes



iOS (274 PINs blocked)
Data-Driven Small (27 PINs blocked)
Data-Driven Large (2740 PINs blocked)

Observations:

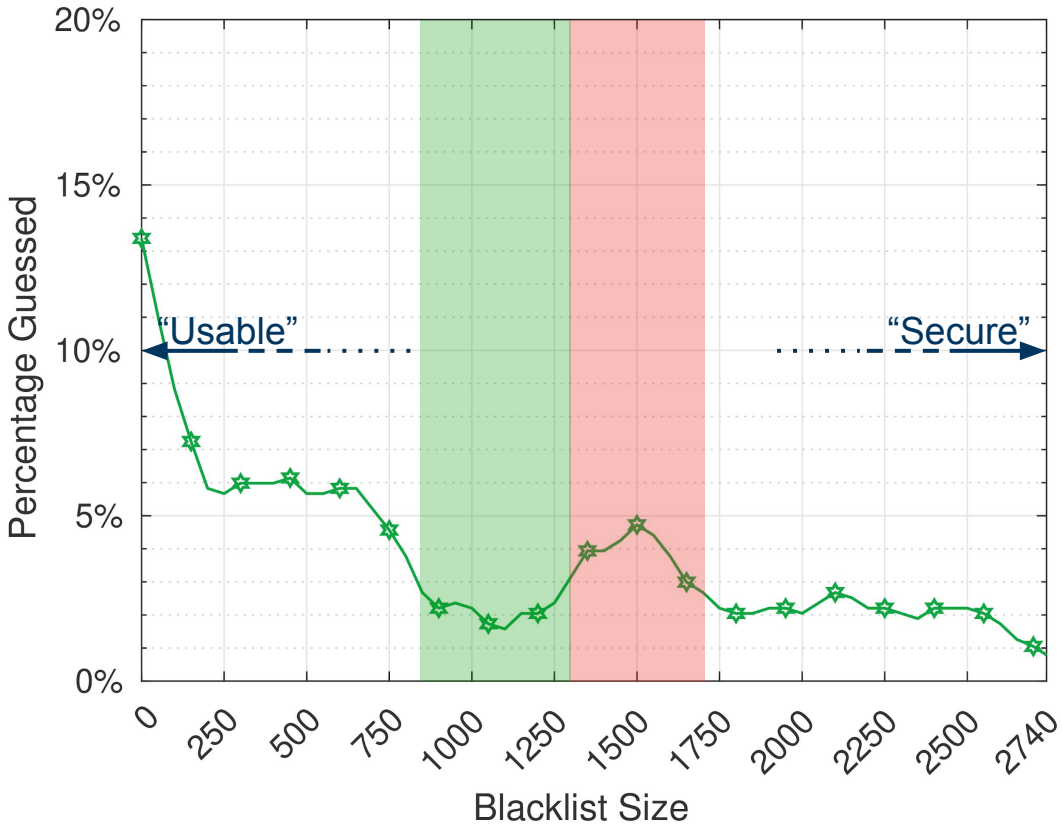
- *iOS* and *Data-Driven Small* offer comparable security
- *Data-Driven Large* drastically increases the security
- Blocklist Hitrate:

DD Small 5%

iOS 15%

DD Large 70%

RQ3: Balancing Security and Usability



Observations:

- Different extrema throughout the curve
- Maxima:
  users choose popular PINs
- Minima:
  users choose unpopular PINs
- Blocking ~10% is ideal

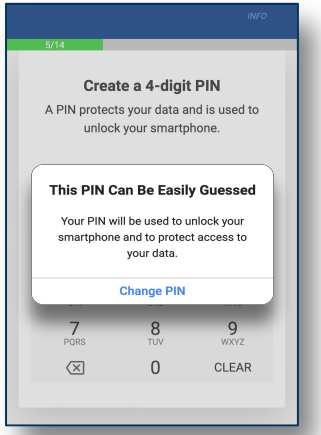
Takeaways

No biometric

Biometric

Most of the participants
in our study (66%) use a PIN

Why study PINs?



User Study

4 ≈ 6 Security of 4- and 6-digit PINs is comparable

XXL Blocklists need to be large to have an effect

Blocking ~10% is ideal

Results

philipp.markert@rub.de @philipp_markert https://this-pin-can-be-easily-guessed.github.io