

RSA[®]Conference2019

San Francisco | March 4–8 | Moscone Center



BETTER.

SESSION ID: SEM-M01

The Quest for Usable and Secure Passwords

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The Quest for Usable and Secure Passwords

Felicia Alfieri, Maung Aung, **Lujo Bauer**, Jonathan Bees, **Nicolas Christin**, Jessica Colnago, **Lorrie Faith Cranor**, Summer Devlin, Harold Dixon, Adam L. Durity, Serge Egelman, Pardis Emami-Naeini, Alain Forget, Hana Habib, Philip (Seyoung) Huh, Noah Johnson, Pranshu Kalvani, Patrick Gage Kelley, **Saranga Komanduri**, Joel Lee, Julio López, Michael Maass, **Michelle L. Mazurek**, Darya Melicher, **William Melicher**, Fumiko Noma, Maggie Oates, Timothy Passaro, Sarah Pearman, **Sean M. Segreti**, **Richard Shay**, Chelse Swoopes, Jeremy Thomas, **Blase Ur**, Timothy Vidas

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What's a Good Password?



What's a Good Password? (If You Ask a Search Engine)

“A strong password consists of at least six characters...”

“Has 12 characters, minimum.”

“A strong password should balance the ease of remembering it with the complexity.”

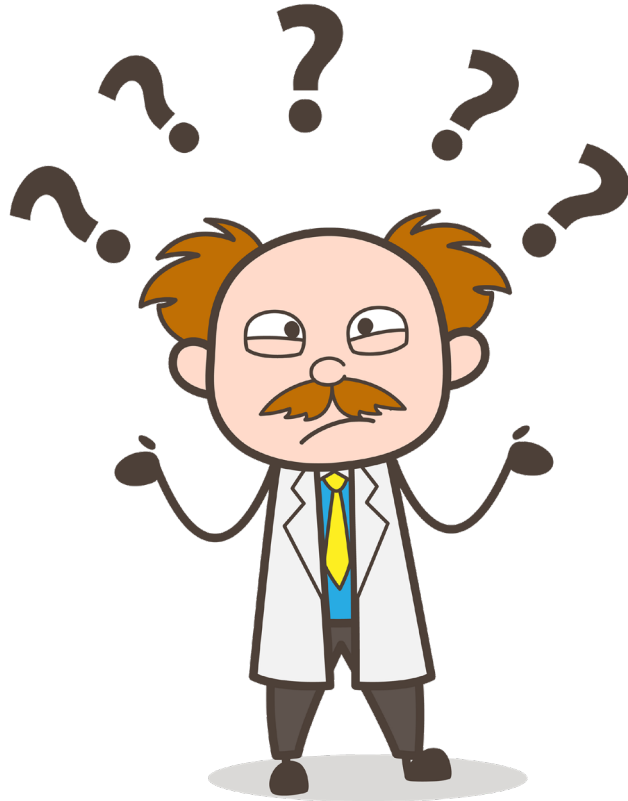
“The best passwords are random...”

“... create a strong password ideas list and use it for all your online accounts.”

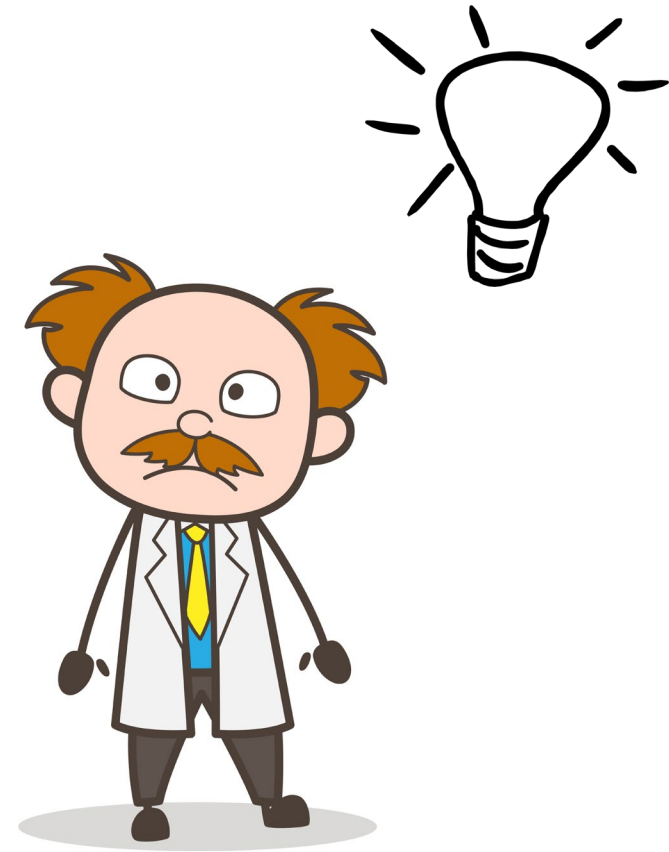
“Learn the secrets to a strong password and dramatically improve your password.”

What's a Good Password? (If You Ask a Scientist)

In 2008



In 2018



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Our Decade-long Quest for Secure and Usable Passwords



How Do We Make Passwords Better?

Goal: Make passwords harder to guess
... without making them too hard to remember

Tools: Password-composition policies,
password meters, user education, ...

Problem: How to apply and evaluate these tools?

Scientific Experiments Need Data and Measurement

- What to measure?
 - Security (historically: entropy)
 - Usability \approx recall rates, timings, sentiment, ...
- How to obtain passwords?
 - Created under different policies, with/without meters, ...
 - Potential sources: Leaked plaintext passwords, leaked + cracked passwords, online studies, lab studies, real passwords

How to Measure Security of Passwords?

Easy for an attacker to guess → weak / insecure password

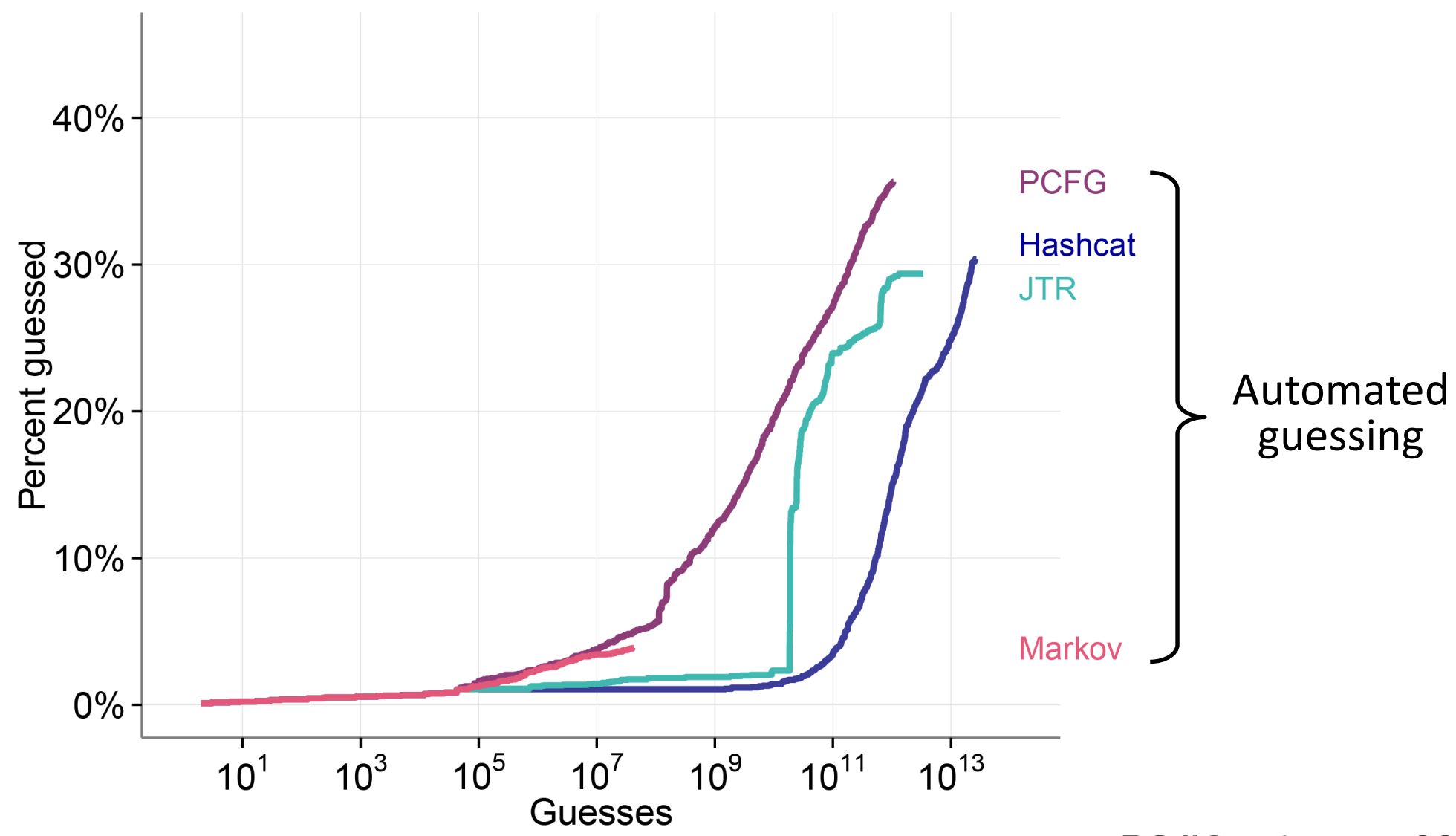
Hard for an attacker to guess → strong / secure password

Our approach: Measure security by simulating how long an attacker would need to guess a password

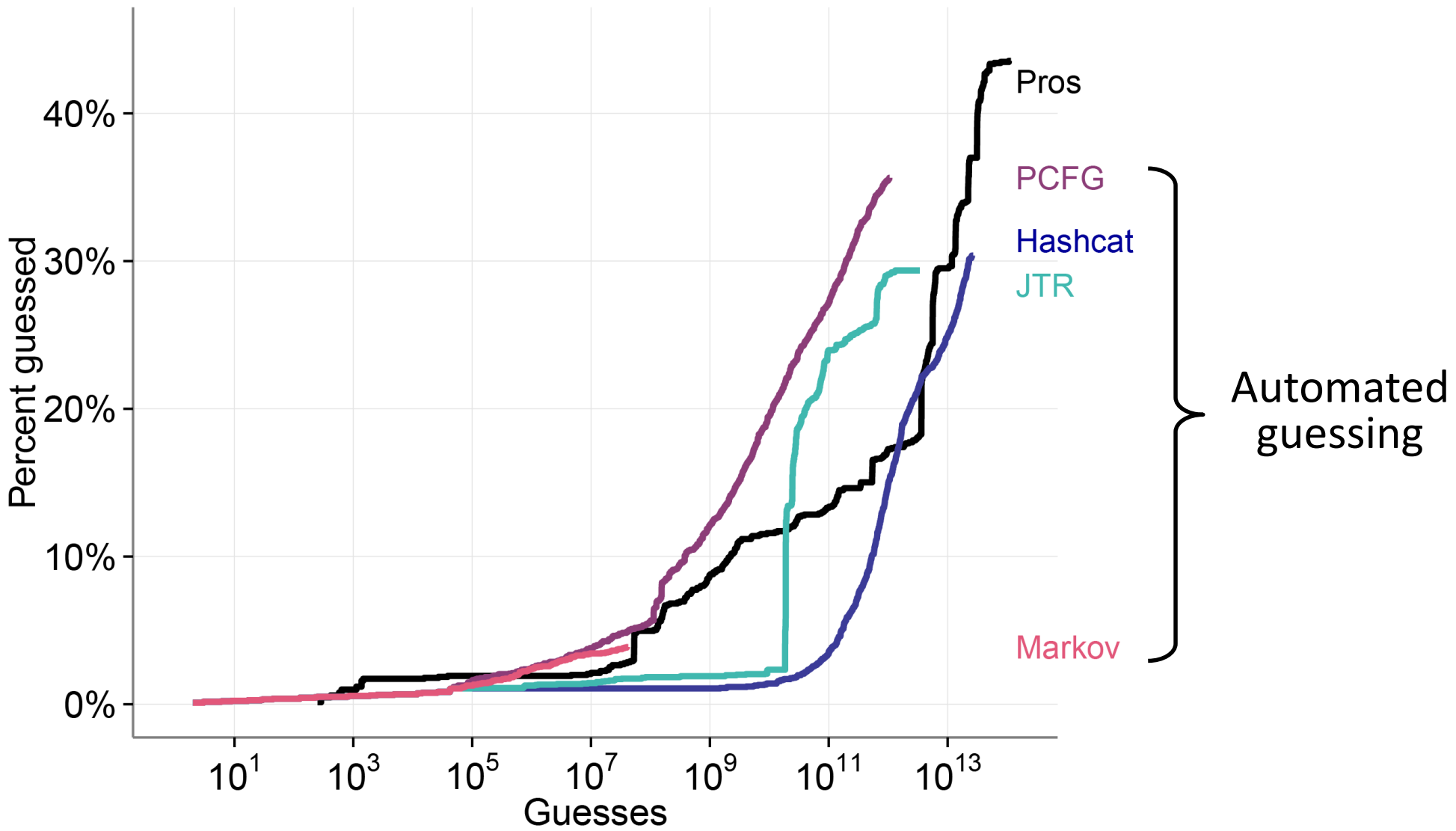
How to Simulate Attacker?

- Compared 4 main guessing algorithms/tools
 - John the Ripper (JTR)
 - Hashcat
 - Markov model-based
 - PCFG
 - And hired a professional password recovery firm!
 - Professionals \approx attackers
- × many configs and training data sets

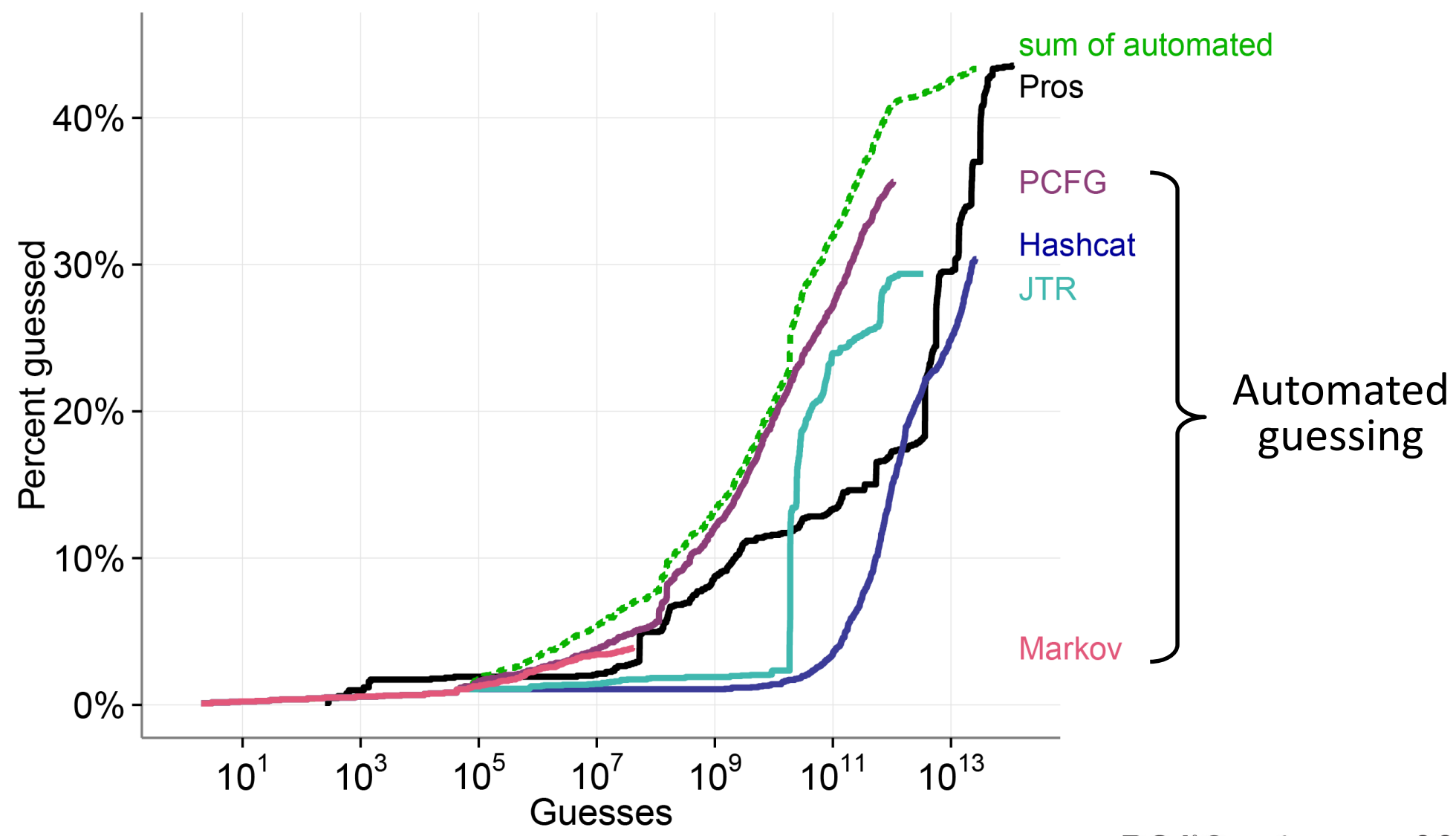
Comparing Approaches to Simulate Attacker



Comparing Approaches to Simulate Attacker



Finding: Sum of Automated Guessing \approx Attackers



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Scientific Experiments Need Data and Measurement

- What to measure?

- Security \approx guessability
- Usability \approx recall rates, timings, sentiment, ...

efficiently ?

Deep learning can measure password strength faster and more accurately!

- How to obtain passwords?

- Created under different policies, with/without meters, ...
- Potential sources: Leaked plaintext passwords, leaked + cracked passwords, online studies, lab studies, real passwords

Scientific Experiments Need Data and Measurement

- What to measure?

- Security \approx guessability
- Usability \approx recall rates, timings, sentiment, ...



Pwd strength calculation service:
pgs.ece.cmu.edu

Neural network:
[github.com/cupslab/
neural_network_cracking](https://github.com/cupslab/neural_network_cracking)

- How to obtain passwords?

- Created under different policies, with/without meters, ...
- Potential sources: Leaked plaintext passwords, leaked + cracked passwords, online studies, lab studies, real passwords

Scientific Experiments Need Data and Measurement

- What to measure?
 - Security \approx guessability
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How to Obtain Passwords to Study?

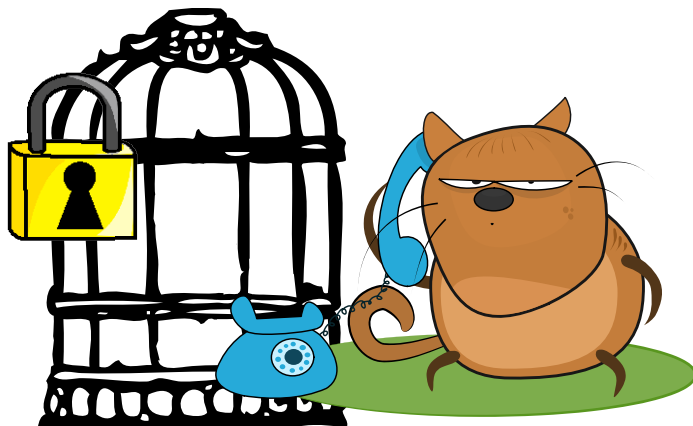
Recipe:

1. Become *very* good friends with IT and information security groups at your institution
2. Collect real-world plaintext passwords for analysis
3. Compare strength against: leaked plaintext passwords, leaked + cracked passwords, online studies, lab studies

How to Obtain Passwords to Study?

Recipe:

1. Become *very* good friends with IT and information security groups at your institution
2. Collect real-world plaintext passwords for analysis



How to Obtain Passwords to Study?

Outcome:

1. Passwords collected in *carefully crafted* online studies can be a good approximation of real-world passwords*
2. Yes, computer scientists have stronger passwords than engineers**
3. ... but both have much stronger passwords than business school students and faculty***

Scientific Experiments Need Data and Measurement

- What to measure?
 - Security \approx guessability
 - Usability \approx recall rates, timings, sentiment, ...
- How to obtain passwords?
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 - Potential sources: Leaked plaintext passwords, leaked + cracked passwords, online studies, lab studies, real passwords



100,000+ User Study Passwords Later ...

Some insights and guidelines for strong and usable passwords

- Length is better than complexity for both security and usability
 - But need a little complexity, too
- Blacklisting weak passwords is a must
 - But have to explain reasoning to users, too
- Feedback to users can help to create stronger passwords
 - But can't be too strict or too complicated
- ...

100,000+ User Study Passwords Later ...

Some insights and guidelines for strong and usable passwords

+

neural networks to measure strength

=

an effective, deployable password meter

100,000+ User Study Passwords Later ...

Feedback based on
data + measurement!

The screenshot shows a password creation form. The 'Username' field contains 'Lujo'. The 'Password' field contains 'Monkey456789' and is highlighted with a red box. Below the password field is a 'Show Password & Detailed Feedback' checkbox. To the right of the password field is a feedback panel, also outlined in red, which contains the following text:

Your password is very easy to guess.

- Don't use dictionary words (**Monkey**) [\(Why?\)](#)
- Capitalize a letter in the middle, rather than the first character [\(Why?\)](#)
- Consider inserting digits into the middle, not just at the end [\(Why?\)](#)

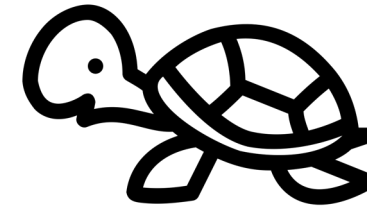
A better choice: **M456789onke>y**

[How to make strong passwords](#)

At the bottom of the form is a 'Continue' button.

What Can Users Do?

- Don't reuse passwords!
- Pick longer passwords, include symbols and numbers (and not just at the end)
- Don't use your pet turtle's name, even if you didn't tell anyone what it was



What Can Information Security Officers Do?

- Relax rules, but weed out common passwords
- Give users feedback about their password:
cups.cs.cmu.edu/meter
- Remember that users have 100 other accounts that are just as important to them

The screenshot shows a web form for password creation. It includes fields for Username (filled with 'Lujo'), Password (filled with 'Monkey456789'), and Confirm Password (empty). A checkbox labeled 'Show Password & Detailed Feedback' is checked. A blue 'Continue' button is at the bottom right. A feedback box on the right states: 'Your password is very easy to guess.' It lists three issues: 'Don't use dictionary words (Monkey)', 'Capitalize a letter in the middle, rather than the first character', and 'Consider inserting digits into the middle, not just at the end'. It suggests a better choice: 'M456789onke>y' and provides a link to 'How to make strong passwords'.

Username
Lujo

Password
Monkey456789

Show Password & Detailed Feedback ☒

Confirm Password

Continue

Your password is very easy to guess.

- Don't use dictionary words ([Why?](#))
(Monkey)
- Capitalize a letter in the middle, rather than the first character ([Why?](#))
- Consider inserting digits into the middle, not just at the end ([Why?](#))

A better choice: M456789onke>y

[How to make strong passwords](#)

What Can Usable Security Researchers Do?

- Adopt our methodology to study passwords (and other usability problems!)
- Use our password guessability service: pgs.ece.cmu.edu