Password Cracking 201: Beyond the Basics

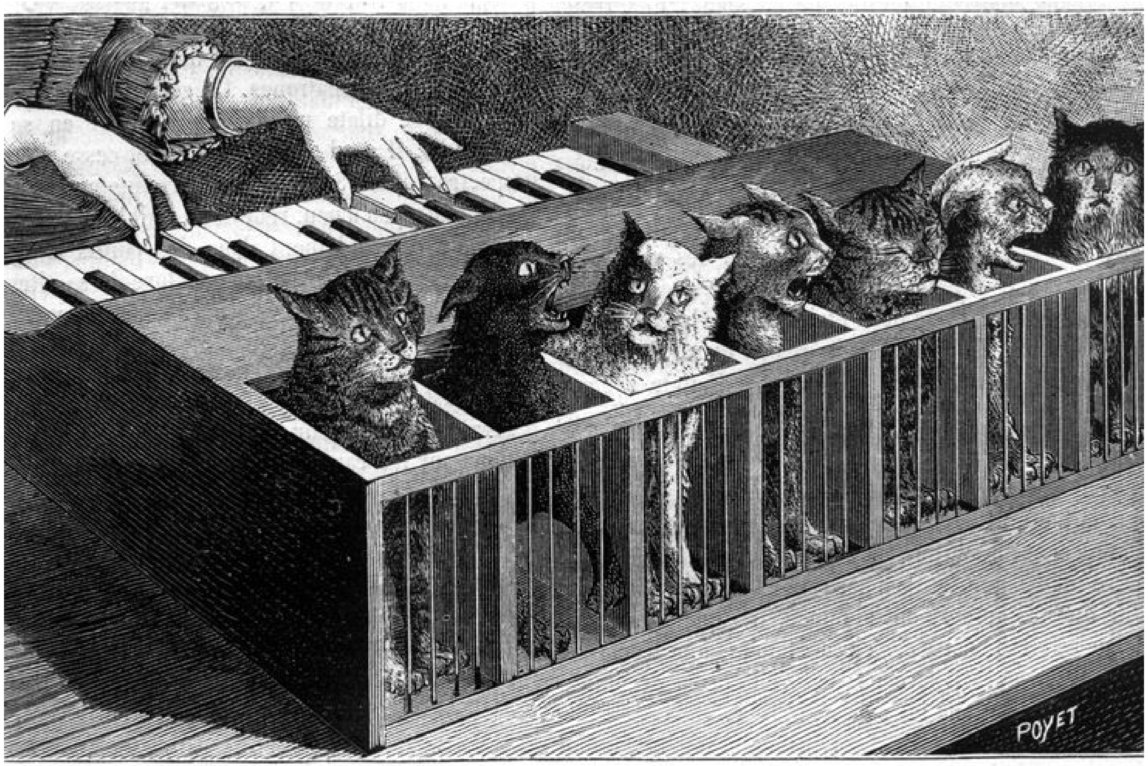


Fig. 1. — Un piano de chats. (D'après une gravure du dix-septième siècle.)

Royce Williams

BSidesLV, Ground1234! track – July 26, 2017

Overview

About me
About you (Types of password crackers)
A brief 101 – password cracking and psychology
Cracking constraints
Core attacks and common pitfalls
Bootstrap tips
Questions

Disclaimers

My interpretation of some community consensus
(mostly from hashcat & John the Ripper)

I am not a lawyer and this is not legal advice

Your organization or jurisdiction may be different

Warning: may irritate and/or bore the experts

About me

$DAYJOB in InfoSec in the financial sector

ISP scars

Independent security researcher

Password auditor and enthusiast

Enjoys long keyboard walks on the beach

About you
(types of password crackers)

- Infrequent audit/recovery (means to an end)
- Internal password auditors
- Password auditing consultants
- Pentesters
- Forensic investigators
- Researchers / academics
- Competition participants
- Enthusiasts
- Bounty crackers
- … and black-hat equivalents of some of these

These can (and do) overlap

Learn from other disciplines

* Follow *and interact with* the people outside of your discipline.

* Read their work - but more importantly, **study their goals**.

* Most have a common interest in *efficiency within time constraints*
… but there are other common interests

* Some disciplines – pentesters, auditors - grok password selection patterns across many organizations.
This is a competitive advantage - often not published, so pay attention when it is

Password activities: a taxonomy (draft)	Work directly for entity that owns the hashes?	Clear hash ownership ?	Authorized by user?	Authorized by hash owner?	Recurring against same targets over time?	Restricted time period?	Exposed to a wide variety of plains over time?	Exposed to a wide variety of hash types over time?
Infrequent recovery (means to an end)	Y	Y	Y	Y	N	varies	N	N
Internal corp password audit	Y	Y	N/A	Y	Y	Y	N	N
Password auditing (consultants)	N	Y	N/A	Y	Y	Y	Y	N
Internal pentest (red team)	Y	Y	N/A	Y	Y	Y	N	N
External pentest	N	Y	N/A	Y	Y	Y	Y	N
Internal forensics (staff InfoSec)	Y	Y	N	Y	?	Y	N	N
External forensics (LE)	N	?	?	?	?	Y	Y	N
Password research	N	?	?	?	?	measure	Y	?
Competition: well-sourced, timed	Y	Y	N/A	Y	N	Y	Y	Y
Competition: well-sourced, untimed	Y	Y	N/A	Y	N	N	Y	Y
Competition, poorly-sourced, timed	?	N	?	?	?	Y	Y	Y
Competition, poorly-sourced, untimed	?	N	?	?	?	N	Y	Y
Cracking for bounty (forums, etc.)	?	?	?	?	?	varies	Y	Y
Enthusiast activities	N	?	?	?	N	varies	Y	Y
Bad guy activities	N	Y	N	N	?	varies	varies	?

Prerequisites and assumptions

1. You want to crack passwords:

- more consistently
- with more results sooner
- with better *understanding*

… and to continually improve over time

Prerequisites and assumptions

2. You have general password-cracking software ...

FOSS	Free (as in beer), closed source	Commercial	
John the Ripper	InsidePro	ACCESSDATA	John the Ripper *Pro*
DaveGrohl	MDXFIND	ELCOMSOFT PROACTIVE SOFTWARE	LØPHTCRACK
		hashstack	PASSCAPE
		Has	Passware
			Tableau

Prerequisites and assumptions

3. You have some hashes (an *offline* attack):

```
$2a$12$2mMZzXhVGss5HlGZGKTgjuacYzlOgLoqwkHdeDSS5/7232t/ZluNq

_q0..6704amnbqWdjdfs  $sha1$15100$jiJDkz0E$E8C7RQAD3NetbSDz7puNAY.5Y2jr

f3bbbd66a63d4bf1747940578ec3d0103530e21d

SCRYPT:1024:1:1:MzM0NA==:LdHQwHIciz9N1HZQ9O1eOkxKCCgnW+Sv015WpZ2Su3A=

$1$57784108$grgZw95/LN9eIXxaETHv00  $apr1$08242617$skwyr2o88OWLGaSUqdMGK.

Administrator::24FCC5E8753EA7DCAD0C0724C88E0133:91D95FEFFC9963CC759FC4B338BDE1BB:::

36BYJUMId/4AM    bba55a0d356d3af89354f6cd7c95b571    51c4d477273a064c

t5a8soeju4i8khkrcctu3cp4ddi1ac8i:.bsideslv.org:82205656:1
```

Prerequisites and assumptions

4. You are familiar with hashing for password “storage”:

- Not stored, but *hashed* (one way; resulting string is fixed length)
- Some are *salted* (good)*;* others are *unsalted* (naive/outdated)
- Salts slow down cracking large lists, *not individual hashes*
- Some hashes are *slow* (bcrypt) – bad for the attacker
- Others are *fast* (unsalted MD5) – good for the attacker
- **If you are saying “decrypted” or “dehashed” … No.**

Good overview: https://security.stackexchange.com/questions/211#31846 (Pornin)

Prerequisites and assumptions

5. You know some basic password cracking *attacks*:

- Straight wordlist / dictionary
- Rules (“password” + “c $1” = “Password1”)
- Combinator (list (“za”, “b”, “c”) produces “bza”, “cza”, “zab” …)
- Masks (“?u?l?l?l?d?d?d?d?s” - matches “Fall2017!”)
- Hybrid dict+mask (lucky?d = lucky1, lucky2 …) or mask+dict
- Brute force (?a?a?a?a?a = **all** six-char ASCII passwords)

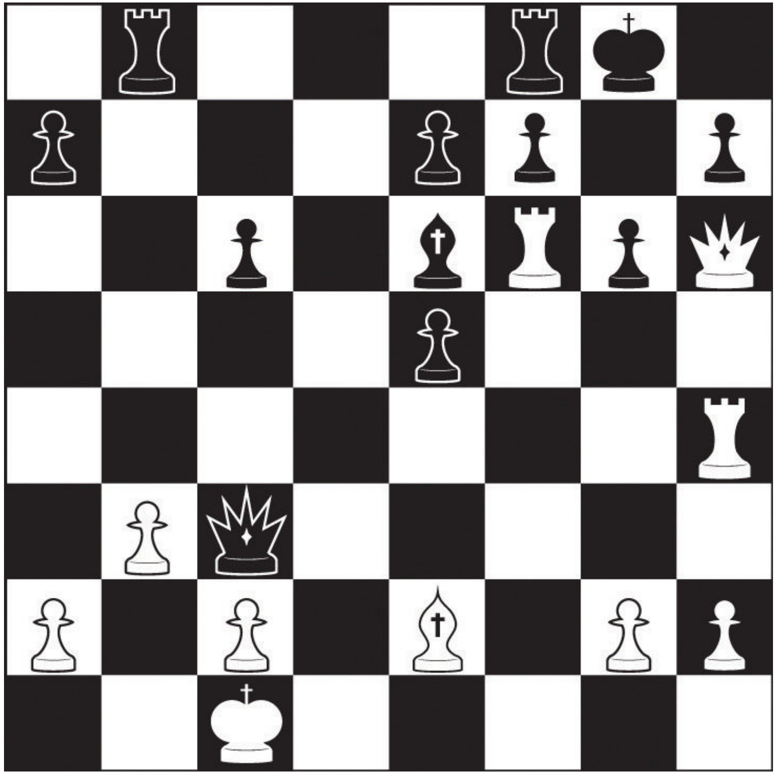
Masks and bruteforce guess in an intelligent order (Markov)

Prerequisites and assumptions

6. You know some basic password management psychology

- Human memory is finite
- We compensate for this with *chunking*

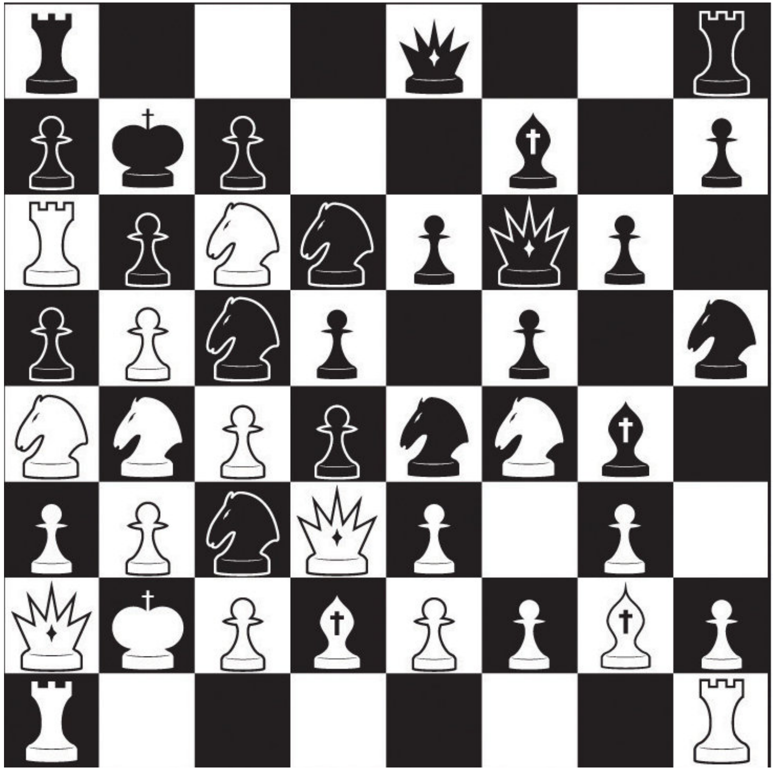
Chunking



Because chess experts can “chunk”, they strongly outperform novices in board layout memorization tasks for valid chess games ...

Source: Stangor, Introduction to Psychology, Ch 8 (fair use)

Chunking

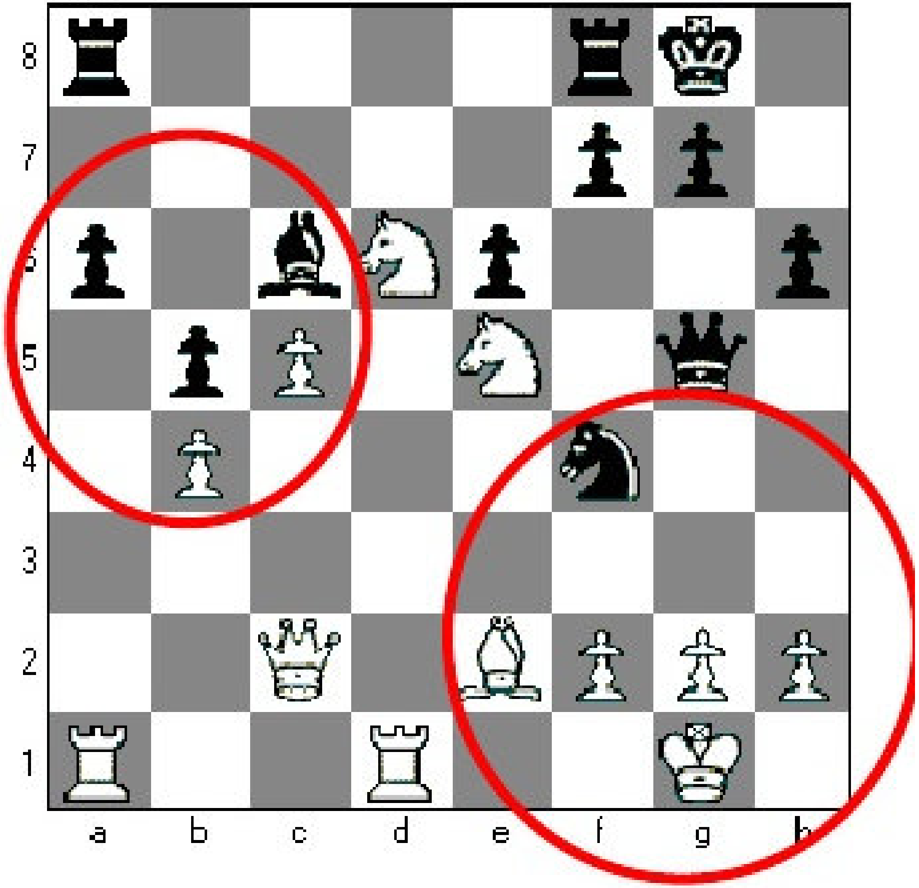


… but when presented with a *random* board layout, experts **perform no better**

Source: Stangor, Introduction to Psychology, Ch 8 (fair use)

Chunking

Experts memorize complex board layouts efficiently, because they can *“chunk”* the board into sets of familiar patterns



Source: Gobet, 2011 in re Chase and Simon 1973 (fair use)

Chunking in password schemes

“My son’s name, all lower case, with his birth year at the end”

```
kevin1963
```

... is (very roughly) **five** “chunks” of information:

1) A specific person’s name
2) The case of the name
3) Their specific birth year
4) The length of the birth year (YY vs YYYY)
5) The method/order of appending (vs. “1963kevin”)

Cracking guided by known chunking strategies is *much* less expensive than bruteforce

Attacking the chunks

To crack many passwords using the ‘`kevin1963`’ scheme:

Wordlist: Facebook names (in frequency order):

http://downloads.skullsecurity.org/passwords/facebook-firstnames-withcount.txt.bz2

Attack: Appending digits to a wordlist (hashcat, on GPU):

```
$ ./hashcat -a 6 -m 0 test.md5 -j l facebook.txt ?d?d?d?d
```

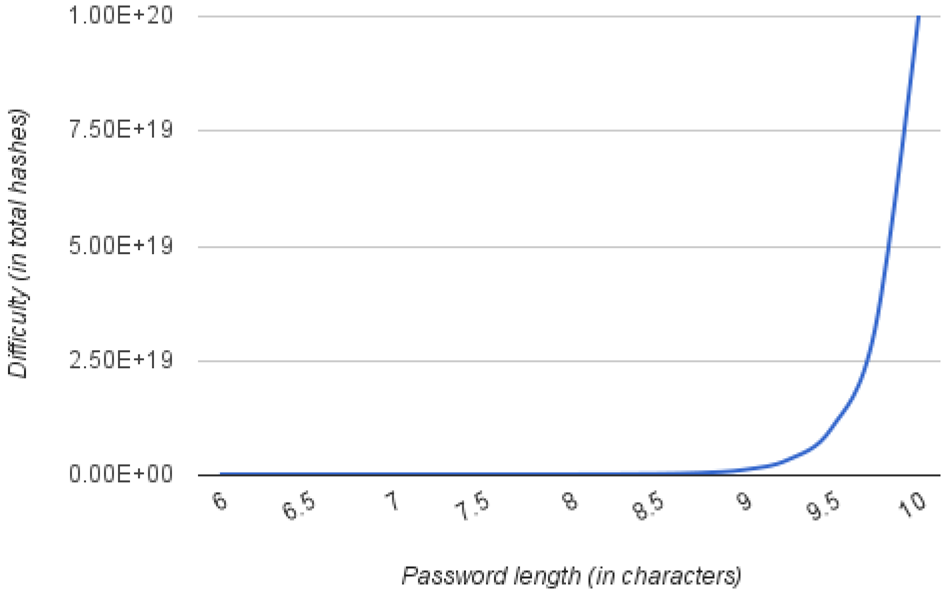
For all of SkullSecurity’s Facebook name wordlists (2010):
http://www.skullsecurity.org/blog/?p=887

Cracking constraints

Source: https://www.flickr.com/photos/tanj/3838754485/ - CC-BY-2.0

Cracking constraints: Math/physics

The exponential nature of bruteforce



Source: http://blog.erratasec.com/2011/06/password-cracking-mining-and-gpus.html

See also Rob’s blog post: http://blog.erratasec.com/2012/08/common-misconceptions-of-password.html

And his talk at Passwords ‘13: https://www.youtube.com/watch?v=dM0iZvR786Q

Cracking constraints: Math/physics

The exponential nature of bruteforce – crosscheck

```
$ python -c 'print 95**2'
9025
$ python -c 'print 95**3'
857375
$ python -c 'print 95**4'
81450625
$ python -c 'print 95**5'
7737809375
$ python -c 'print 95**6'
735091890625
$ python -c 'print 95**7'
69833729609375
$ python -c 'print 95**8'
6634204312890625
$ python -c 'print 95**9'
630249409724609375
$ python -c 'print 95**10'
59873693923837890625
```

<------------------------- This is **$5.9x10^{19}$**

Assume that we have no idea what characters might be used, (other than that they are printable ASCII / 95 characters)

Cracking constraints: Math/physics

The exponential nature of bruteforce - crosscheck

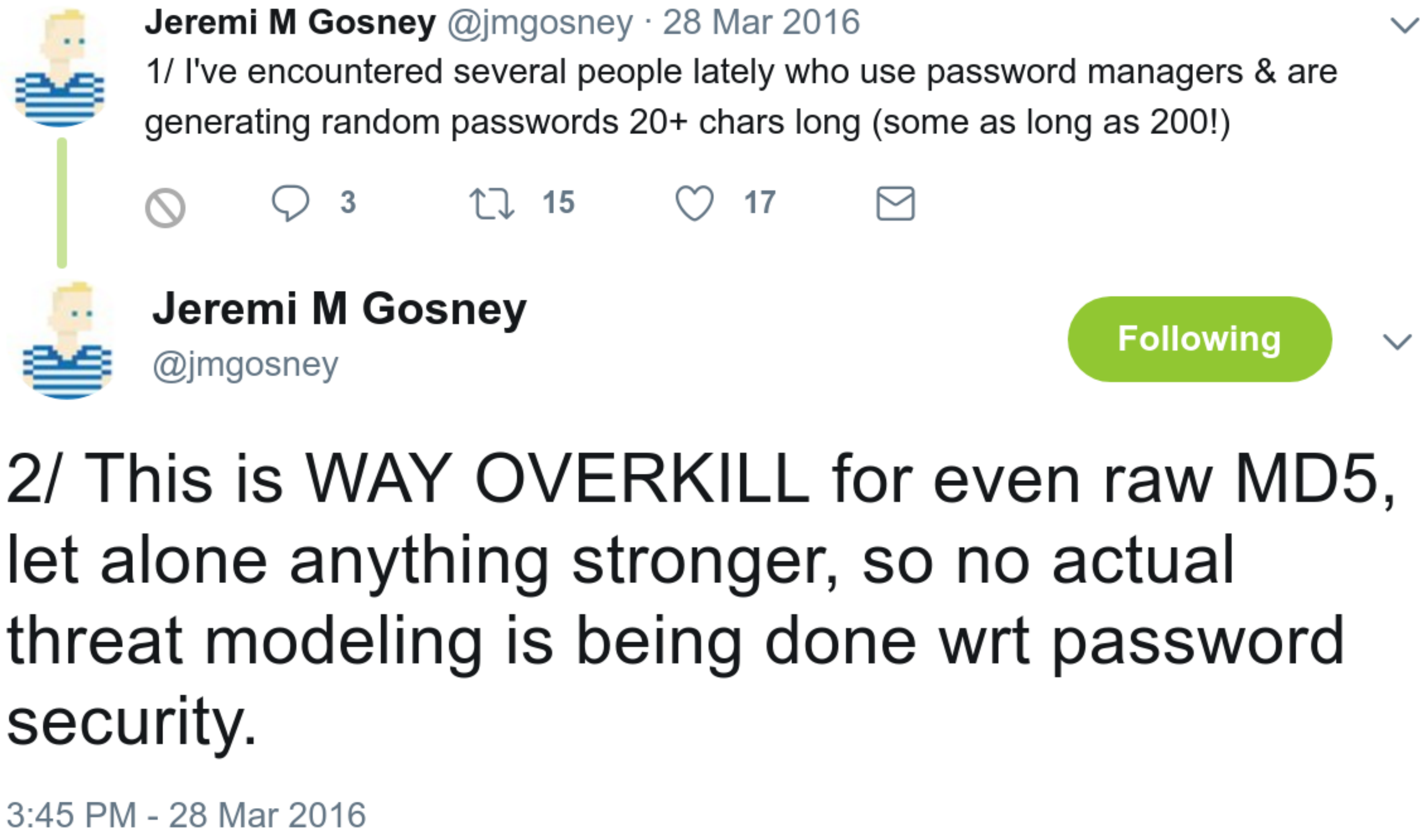
```
# Benchmark for MD5 (mode 0), 6x GTX 1080, no overclock

$ hashcat -b -m 0 --quiet

Hashtype: MD5

Speed.Dev.#1.....: 25434.5 MH/s (52.74ms)
Speed.Dev.#2.....: 24610.4 MH/s (54.48ms)
Speed.Dev.#3.....: 24968.4 MH/s (53.72ms)
Speed.Dev.#4.....: 24923.4 MH/s (53.82ms)
Speed.Dev.#5.....: 24015.1 MH/s (53.70ms)
Speed.Dev.#6.....: 25002.8 MH/s (53.64ms)
Speed.Dev.#*.....:   149.0 GH/s
```

Cracking constraints: Math/physics

The exponential nature of bruteforce - crosscheck

```
$ hashcat -b -m 0 --quiet --machine-readable
 1:0:1746:4513:53.02:25294033130
 2:0:1733:4513:54.12:24427650923
 3:0:1771:4513:53.67:24987941094
 4:0:1746:4513:53.81:24925294904
 5:0:1721:4513:53.10:25257382009
 6:0:1784:4513:53.47:24999576814 = 150302475476 hashes/sec

 # Hours to exhaust ?a at length 8
 $ python -c 'print (6634204312890625/150302475476)/60/60'
 12
 # Days to exhaust ?a at length 9
 $ python -c 'print (630249409724609375/150302475476)/60/60/24'
 48
 # Years to exhaust ?a at length 10
 $ python -c 'print (59873693923837890625/150302475476)/60/60/24/365'
 12
```

Cracking constraints: Math/physics



Jeremi M Gosney @jmgosney · 28 Mar 2016

1/ I've encountered several people lately who use password managers & are generating random passwords 20+ chars long (some as long as 200!)

Jeremi M Gosney
@jmgosney

2/ This is WAY OVERKILL for even raw MD5, let alone anything stronger, so no actual threat modeling is being done wrt password security.

3:45 PM - 28 Mar 2016

Cracking constraints: Math/physics

How long should your **random** password be?

ceil(logC (H * Y * 31556926 [sec/year]))

C = charset count
H = adversary hashrate
Y = years to crack

Source rant: https://twitter.com/jmgosney/status/714599158229786625

Cracking constraints: Math/physics

How long should your **random** password be?

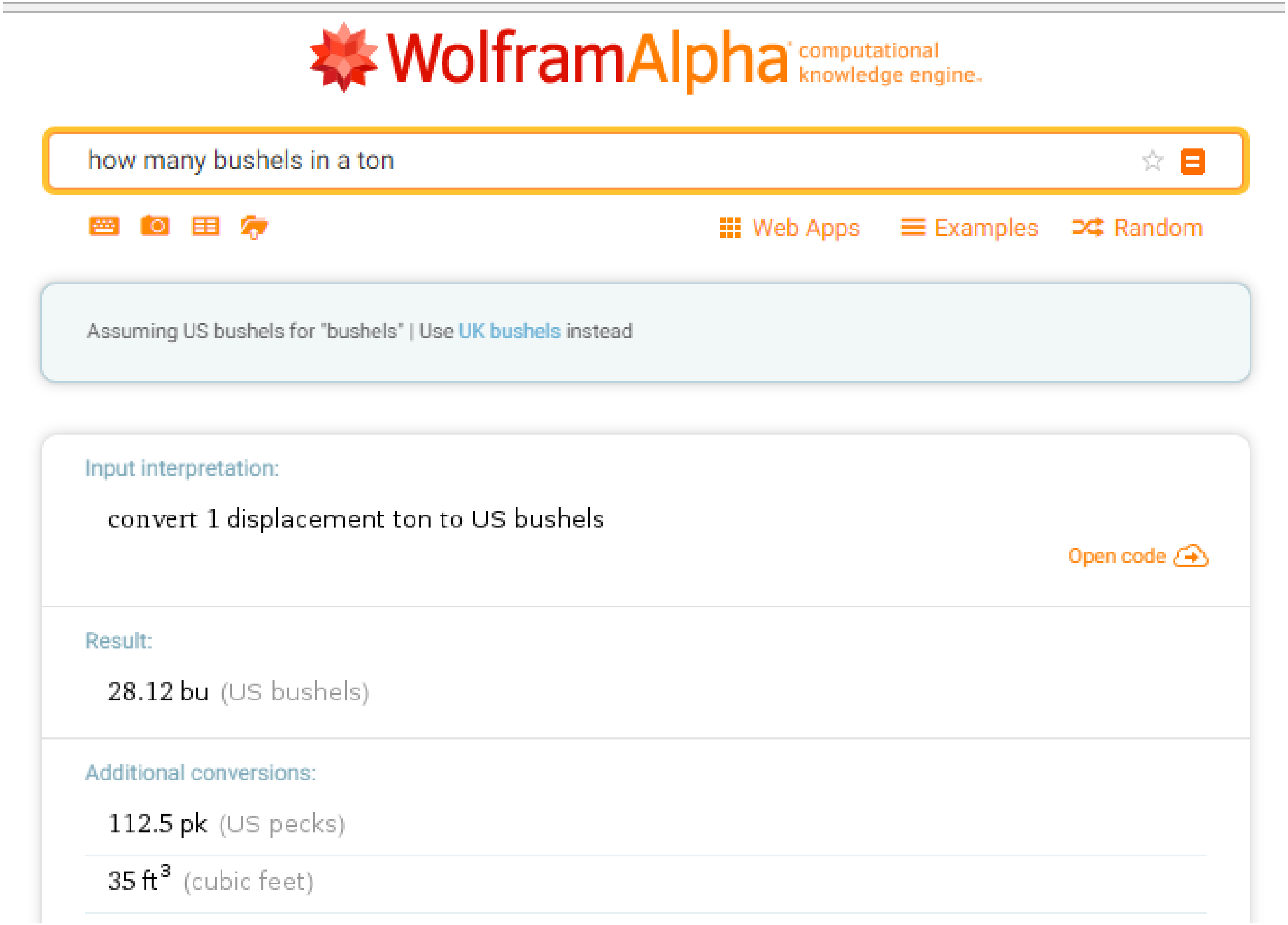
ceil(logC (H * Y * 31556926 [sec/year]))

*(Assuming: C = **alphanum** (62 chars), H = **100TH/s**, Y = **100 years)***

... the non-Moore’s-law-aware answer is **14 characters:**

```
IoI8Oasu93H6oN
XxCp8KekKhR1A6
vnhkx7qMNOpGHo
TKheK2Mzkw63IP
s
```

(and per the anrieff.net calculator, w/Moore’s Law, it would be 16 years 2 months)



how many bushels in a ton

Assuming US bushels for "bushels" | Use UK bushels instead

Input interpretation:

convert 1 displacement ton to US bushels

Result:

28.12 bu (US bushels)

Additional conversions:

112.5 pk (US pecks)

35 ft^3 (cubic feet)

Cracking constraints: Math/physics

How long should your random pass**phrase** be?

ceil(logC (H * Y * 31556926 [sec/year]))

*(Assuming: C = **17K word dictionary**, H = **0.1TH/s**, Y = **1 year**)*

= **5 words**, *regardless of other complexity*

```
cain mystery ahoy discourse serpent
 stares perkiness begs fleshy form
eternal belonged sane allowing disc
```

Adjust the parameters based on your threat model
Add trivial complexity for any sites that require it

Cracking constraints: Math/physics

Just in case you’re also worried about time travelers
or inter-dimensional aliens:

Landauer's principle: theoretical minimum energy of **one bit flip** of information

The mass-energy of the sun = $2^{225.2}$ operations (Pornin)

225 bits = **35-character** (95 printable ASCII) passwords

(Hat tip: James Wu / @analogist_net)

Cracking constraints: The target

- Speed of the hash
  - You can be ~~lazy~~ experimental with faster hashes
  - Slow hashes = harder w/o knowledge of target
- Size of the target
  - 61M SHA1 from a public leak? Try it all!
  - A single WPA2? Target knowledge needed
- Your knowledge of the target
  - Some good OSINT tools - but there is a limit
  - Demographics and sophistication of the target
- Requirements (usually detectable)

Cracking constraints: Capabilities (1)

- Software availability and algorithm support
- Cracking technique awareness
- Your available attention / energy / motivation

Cracking constraints: Capabilities (2)

- Raw *cracking-specific* compute capability
- Your ability to turn target knowledge into inputs
- Quality of inputs (wordlists, rules, masks, etc.)
- Initial attack “spin-up” / prep latency (script this!)

Platform considerations

Source: Flickr user kentwang - CC BY-SA 2.0

OS / hardware / admin hints

- Use the native OS (not a VM) if you can
- Kali’s OpenCL and Intel OpenCL are problematic
- Use the latest stable video drivers, not OS stock
- Use the john “jumbo” & latest hashcat releases …
- … but **also** keep betas and latest GitHub available
- … and make it easy to quickly run any of them
- For NVIDIA GPUs, use reference/Founders models
  - Very hardy, built to exact NVIDIA specs
- Consider locking fan speed (80%? 100%?) based on your thermal risk models

Use the FOSS, Luke ...

- No arbitrary caps on target size
- Scriptable
- Multi-OS, multi-platform
- Cross-pollination among projects
- Opportunity to directly contribute
- stdin … and stdout

… but embrace the Dark Side ;)

- Ease of use
  - GUI
  - Canned wordlists and rules
  - Often good attack-plan management
  - Built-in distributed processing
- Some suites have free trials
- Some free front-ends (Hashtopussy, Hashview) have similar features

¿Por que no los dos?

- Use both FOSS and commercial – whichever are the right tools for *your* use cases
- It’s Free to add FOSS. And some non-free are very affordable
- Play with *all of them.* More exposure = more perspective
- Press your vendors for more interoperability (stdin/stdout support), custom rules, etc.

Input management

Source: http://www.neogaf.com/forum/showpost.php?p=110289415&postcount=232

Wordlist management (1)

- Focus on *human-generated strings*
- Quality over quantity
- Single best public source for founds: hashes.org
  - Based wholly on public leaks (AFAICT)
  - Lists both found and remaining hashes, per leak
  - Has an API for submission of new founds
- For slow hashes, bulk harvest from context (CewL, Maltego, etc.)

Wordlist management (2)

- All human-generated strings are fair game
- Wikipedia/Wikia (long tail of fictional words/phrases)
- Domain names and hostnames (Rapid7 Project Sonar DNS ANY)
- Usernames / email addresses / given/family names …
- Street addresses, lyrics, movie subtitles, Project Gutenberg ...
- In other words – things that people remember that you can harvest in bulk
- These need to be normalized and deduped

Wordlist management (3)

- Deduplicate *by type* (superset of **all** email addresses, etc.)
    - `rli` and `rli2` from hashcat-utils are **the** go-to tools
- **Build a superset, but retain per-source dictionaries**
- Watch RuraPenthe’s talk on wordlist grooming:

  https://www.youtube.com/watch?v=IGbceBOVYI
- Some people import into databases … mixed consensus
    - Probably a 301-level activity :)
    - I prefer plain text files (the trade-off is more disk space)

Wordlist conversion

- If not in UTF-8, convert to UTF-8 with `iconv`
- … but **keep the originals**
- HTML escapes? Use RuraPenthe’s `rurasort`

Baseword extraction

- *Stemming* - deriving original base words from plains

“Ground1234!” → “ground”

- More difficult than it looks – aspell, neural networks
- RuraPenthe’s `rurasort` – lots of different options

Mask management

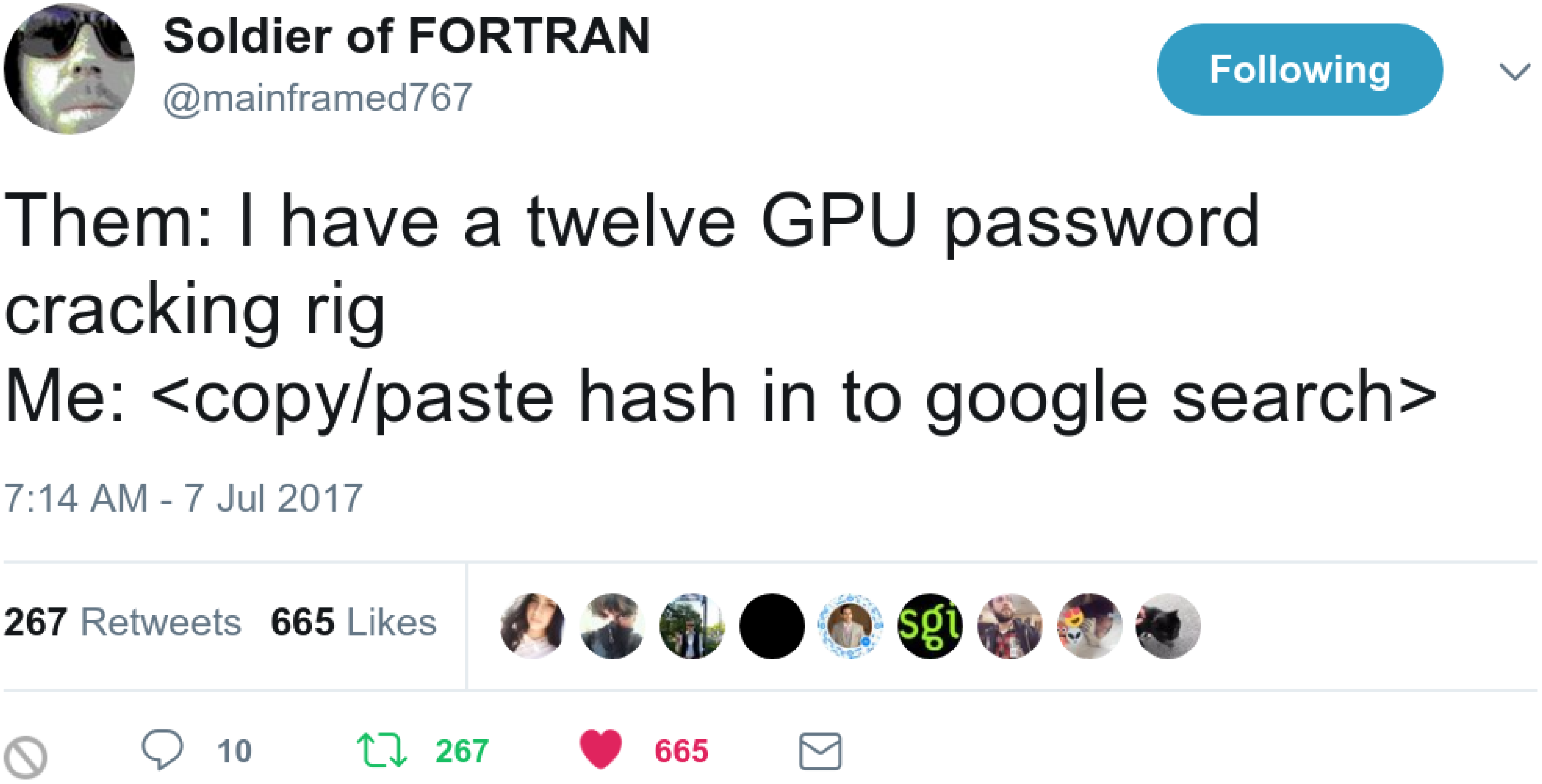
- Grab other people’s masks, like KoreLogic’s
- Make your own from your previous and current cracks - use PACK’s statsgen and maskgen
    - Clients who don’t let you keep plains might let you keep stats
- Keep masks sorted by frequency
- If you get a new list of masks, remove ones that are already exhausted.
    - Hashcat’s .log files note when they are exhausted (and you can harvest / diff the list)
    - Status code definitions are in include/types.h, STATUS_*

Rules management

- Grabbing rules from others
  - Watch: hashcat forums, bartavelle, EvilMog
  - Not all rules are compatible with all suites – see hashcat wiki
  - Some rules are not GPU-or CPU-ready and will be rejected
    - Strip CPU or GPU rules with hashcat-utils' cleanup-rules
- Making your own rules
  - Generate from a given dict and plains list, using bartavelle's rulesfinder (GitHub)
- Deduplicating rules is tricky
    - space vs non-space, and rules that cancel each other out
    - 0xbsec's duprule looks promising – still in development

Attack methods

Cheat



Soldier of FORTRAN
@mainframed767

Them: I have a twelve GPU password cracking rig
Me: <copy/paste hash in to google search>

7:14 AM - 7 Jul 2017

267 Retweets **665** Likes

Cheat ...

- Useful only for unsalted hashes
- Try Google AND Bing, etc (different results sometimes)
- Some specific sites (no specific recommendation - YMMV)

hashcrack.com   hash-killer.com/hashdb
md5center.com   md5-database.xyz
md5decryption.com   md5decrypt.net   md5hashing.net
md5.my-addr.com   www.nitrxgen.net/md5db

... etc.

- Use sites’ own search features – may not be fully spidered
- Sites come and go – scout for new ones
  - Use a web search for a semi-common hash

… but cheat responsibly

- Consider sensitivity of hashes before submitting – they are stored, analyzed, and being cracking (that is what the sites are really for)
- Google/Bing searches may be less likely to expose hashes to third parties (but weigh sensitivity anyway!)
- Third-party pentesters/auditors – think hard

Custom Markov

- Stock Markov sets are often derived from RockYou (100%!)
- This is fine for first passes, but your target may be different
- Use your cracks and hcstatgen to build a custom Markov set:

```
$ ./hcstatgen.bin out.hcstat < infile
```

… and then use it for bruteforce/mask-based attacks

Example: custom Markov based on LinkedIn founds automatically hits strings with “link” “LI” “linked”, etc. more often and earlier in the attack

PRINCE (1)

- PRINCE mode is supported by John natively, and by hashcat as a standalone binary (which you can pipe directly to hashcat)

  In essence, it’s a smart combinator attack that will run forever, combining two words, three words, etc. from a given wordlist
- Using **CPU only** and only RockYou as input, early PRINCE testing cracked 72% of LinkedIn in **24 hours** – *completely automated.*
- Introductory post from the hashcat forums
- Technical details are in slides from atom’s 2014 talk

PRINCE (2)

- I personally credit PRINCE for a lot of what I have learned since it was released … *because it showed me what I didn’t know yet*.
- I run PRINCE in parallel with other runs – on CPU, on a separate box, etc.
- I also run it as an ‘attack of last resort’ to fall back to when other attacks finish and I don’t have something else queued up.
- Use PRINCE. Seriously.

Broad attack guidance

- Don’t be afraid to feed things into other things
- In epixoip’s Circle City Con class, he described “PRINCEPTION” - feeding PRINCE into itself!
- Stdin/stdout and named pipes are key for this exploration
- Use the raw numbers to measure performance – was it worth it?
- Be ready with bash/Python/perl/PowerShell to try things that don’t have a tool yet (that you know of)
- Back up your results(lists, notes, founds, scripts) to reliable media.

Accurate speed estimation

```
$ echo -n bsideslv17 | md5sum | awk '{print $1}' >bslv.hash

$ cat bslv.hash
A3c67ba47cfb67c42840acc21a77211f

$ hashcat --speed-only -b -m 0 --quiet --machine-readable
1:0:-1:-1:53.31:114469177

$ hashcat --speed-only -m 0 -a 3 bslv.hash \
    ?a?a?a?a?a?a?a?a --quiet --machine-readable
1:20133346
```

Actual speed for this attack is ~17.6% of benchmark speed
Use actual speed to create your attack plans

Measuring attack efficiency

- “Wall-clock” time efficiency is relative
- Crack *position* (number of *guesses*) is absolute

Measuring attack efficiency

```
- [ Outfile Formats ] -

  # | Format
 ===+========
  1 | hash[:salt]
  2 | plain
  3 | hash[:salt]:plain
  4 | hex_plain
  5 | hash[:salt]:hex_plain
  6 | plain:hex_plain
  7 | hash[:salt]:plain:hex_plain
  8 | crackpos
  9 | hash[:salt]:crack_pos
 10 | plain:crack_pos
 11 | hash[:salt]:plain:crack_pos
 12 | hex_plain:crack_pos
 13 | hash[:salt]:hex_plain:crack_pos
 14 | plain:hex_plain:crack_pos
 15 | hash[:salt]:plain:hex_plain:crack_pos
```

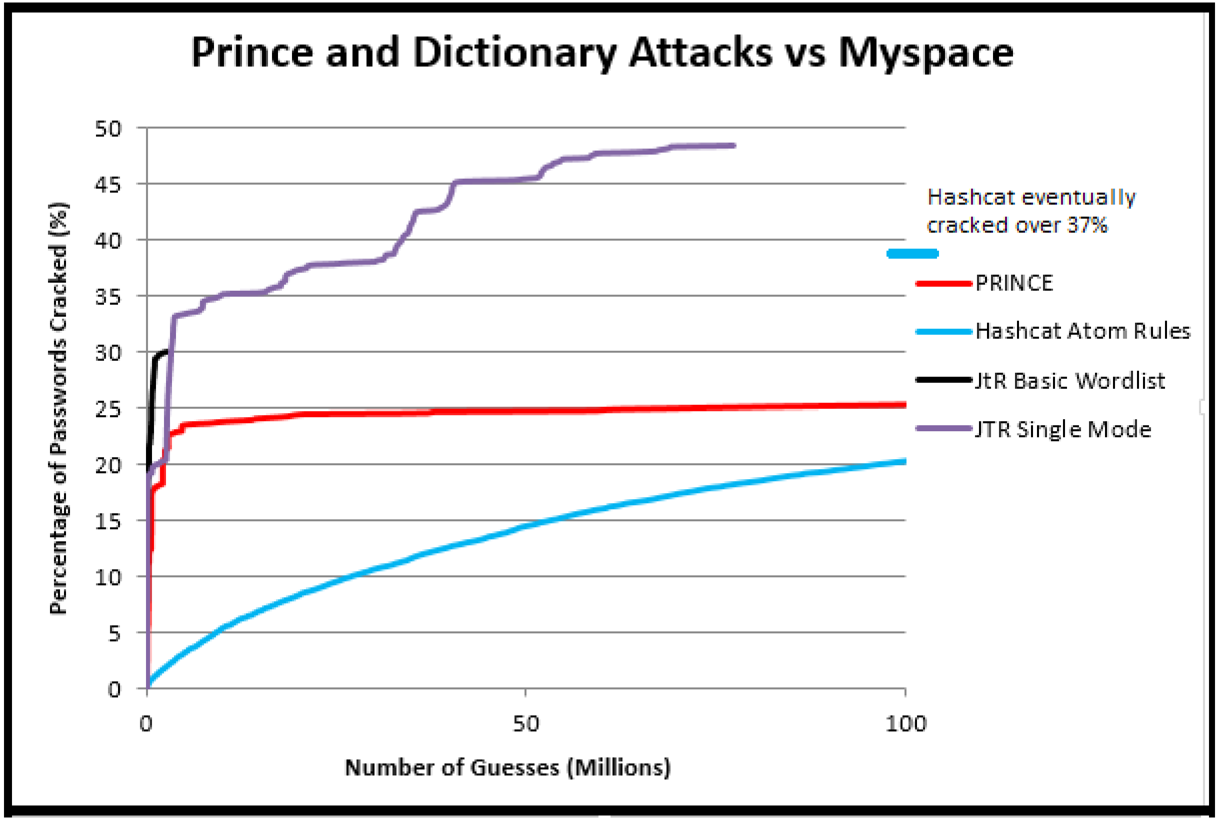
Measuring attack efficiency

```
$ hashcat -a 3 -m 0 testmd5.hash ?l?l?l?l?a?a?a \
    --outfile test1.out --outfile-format 11 \
    --quiet --potfile-path=/dev/null

$ hashcat -a 3 -m 0 testmd5.hash ?l?l?l?l?d?d?d \
    --outfile test2.out --outfile-format 11 \
    --quiet --potfile-path=/dev/null

$ cat test1.out test2.out
7e7da6a03ac3b80bad3f338fffa621d5:hash234:12378814668
7e7da6a03ac3b80bad3f338fffa621d5:hash234:137798556
```

The second attack is 100 times faster than the first -
regardless of the underlying hardware speed

Measuring attack efficiency

Once you have the numbers, plot them (gnuplot, Excel, etc.)



Source: Matt Weir (lakiw) PRINCE analysis

Analyzing cracks and founds

- The PACK toolkit is an essential set of tools
- Build statistics on letter frequency and mix types
- Build lists of masks based on time constraints
- Other fantastic features – definitely a minimum

Working with non-ASCII

- If your plains are in one character encoding and your targets are in another, this won’t work
- Recommendation: convert everything you get to UTF-8
- If your suite doesn’t include encoding conversion tools, use `iconv` to convert to the target encoding
  - Looks like John has good support (not checked)
  - Hashcat recently added encoding-from / encoding-to flags
- Hashcat can do multibyte bruteforce with a workaround (RuraPenthe’s)- works, but tricky; his good writeup here
  - Full example using PACK and German characters: https://security.stackexchange.com/a/154958

Universal attack-plan principles

- With inputs, quality and frequency order matter more than quantity
- Start simple – crack the easy stuff quickly
- If you can cap attack runtime, use it (diminishing Markov returns)
- While that is running, analyze plains for untapped patterns
- Arrange attacks in order by efficiency **for the time allotted**
- Record all attacks, results, and performance (science!)
- Script these and repeat the good attacks on all new founds
- Avoid duplicated masks/wordlists - when it makes sense
- Append a *fallback attack* to each attack plan

Understandable naive approaches

“Where can I get more wordlists? I have 120GB so far.”

Understandable naive approaches

“I’m trying ?a?a?a?a?a?a?a?a?a?a?a?a?a, what next?”

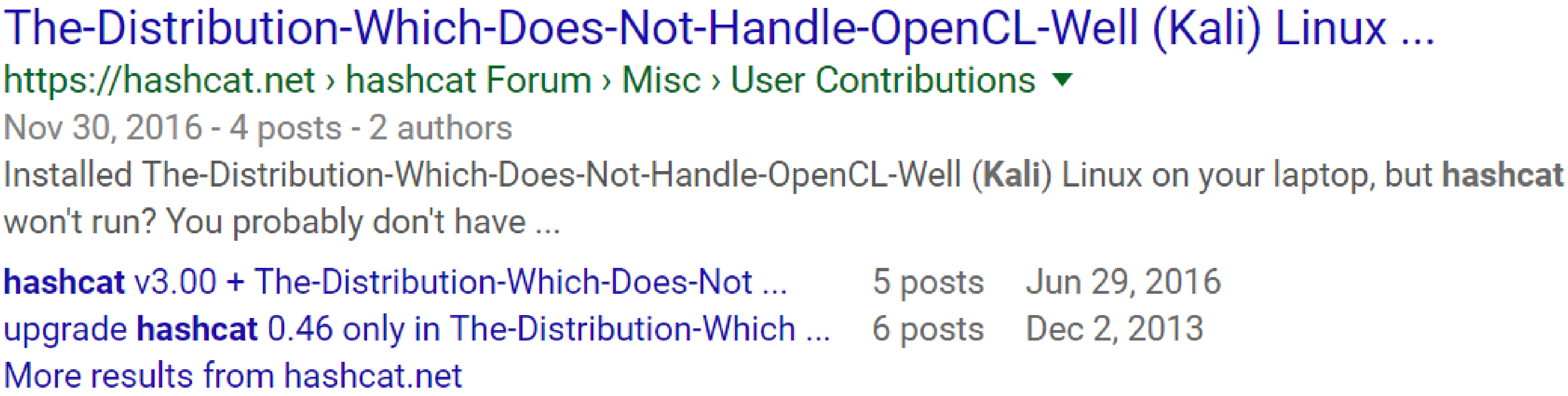
Understandable naive approaches

```
3ce8b30b8e25ea5d9a83d4a073d6ddf8
```

“Ah, this must be MD5 - because it’s 32-character hex.”

Understandable naive approaches

“I’m trying to get hashcat to work in Kali, and ...”



The-Distribution-Which-Does-Not-Handle-OpenCL-Well (Kali) Linux ...

https://hashcat.net › hashcat Forum › Misc › User Contributions ▾

Nov 30, 2016 - 4 posts - 2 authors

Installed The-Distribution-Which-Does-Not-Handle-OpenCL-Well (**Kali**) Linux on your laptop, but **hashcat** won't run? You probably don't have ...

hashcat v3.00 + The-Distribution-Which-Does-Not ...	5 posts	Jun 29, 2016
upgrade **hashcat** 0.46 only in The-Distribution-Which ...	6 posts	Dec 2, 2013

More results from hashcat.net

Learn from history

Great presentation on the history of password security by Solar Designer (@solardiz) and Simon Marechal (@bartavelle):

http://www.openwall.com/presentations/Passwords12-The-Future-Of-Hashing/

Other bootstrapping resources

Hashcat:
wiki, FAQ, forums, IRC (#hashcat on Freenode), GitHub

John:
john-users mailing list, docs, GitHub for jumbo version

General:
Hashkiller.co.uk and InsidePro forums
Passwords & Ground1234! conference talks on YouTube
PasswordResearch.com (Bruce K. Marshall)

Cultural hints

- Like many geek areas, password crackers can be rough on the noobs sometimes
- Information sharing beyond a certain point is limited
- Like BSidesLV, related projects are usually “do-ocracies”
- Show up, roll up your sleeves, don’t ask the same question twice, and if someone sends you a link in answer to your question, you’d better read it.
- The shared common interest makes for a great community

In other words ...

Do not trace the footsteps of the wise;
seek what they sought.

- Bashō (poet, paraphrasing Kūkai (!))

Imitate the intent, not the brush strokes.

- Kūkai (on calligraphy)

Thanks

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coolbry95
CormacHerley
countuponsec
cowboym
cperciva
CrackTheHash

curlyboi
d22
d3ad0ne
DaKahuna
DidierStevens
digininja
doc2n
DoZ10
dropdeadfu
empty_knapsack
epixoip
ErrataRob
EvilMog
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GiftsUngiven
gm4tr1x

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iphelix
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Jumpforce
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Slides, errata, references:
www.techsolvency.com/talks