A Practical Guide to Cybercrime

Dr Richard Clayton
Director, Cambridge Cybercrime Centre

UNIVERSITY OF CAMBRIDGE
Computer Laboratory

GOTO Copenhagen
18th November 2019

My background

- I’ve been looking at online abuse (spam, phishing, malware, DDoS etc) for two decades
- My general approach is data driven (I count things)
- I have obtained many datasets from industry under NDAs and that has underpinned the work I have done (in collaboration with some very smart people)
- BUT this is a long and tedious process, and we’re beginning to realise that no papers in this field can be reproduced (data cannot be shared, results cannot be compared, conclusions cannot be validated)
- This does not really look like science…

Cambridge Cybercrime Centre

- I have 5 years funding from EPSRC (+ some other money)
- Currently 7 of us
- We are interdisciplinary

  Computer Science, Criminology & Psychology
- Our approach is data driven. We aim to leverage our neutral academic status to obtain data and build one of the largest and most diverse datasets that any organisation holds
- We mine and correlate this data to extract information about criminal activity. We are always learning more about crime 'in the cloud', how to detect it better & faster and determine what forensics looks like in this space (and where appropriate we work with LEAs to prevent harm)

Others can play too

- We collect data at scale in a “production” way and integrate with data sourced from others
- We make our data available to others under one simple NDA agreement which is between the researcher and us
- We cannot make the data entirely public (or open) but we *do* make it available to legitimate academics
- We have a ‘catalogue’ of data that can be used in specialist research without the need to learn all about the web scraping, whois limits, duplicated data and all the other complexity
  - it will be easy to set MSc work in this area since it will not take 2 years to get the data together
  - we aim to see more *science* by letting people run different techniques on the same data and compare results

https://www.cambridgecybercrime.uk/process.html

Cambridge Cybercrime Centre: Process for working with our data

This page sets out the steps in the process for obtaining data from the Cybercrime Centre.

Assess whether you will be allowed to use our data

Our datasets are intended for research and analysis into methods to find, understand, investigate and counter cybercrime so your project must clearly fall into this space. Although we do not require reseachers to be academics, there are significant restrictions on using our data for commercial purposes.

Although some of our data was generated internally and so we can make it available for other types of project and for commercial purposes, much of our data has come from third parties and they have only provided us with the data because of the framework under which it will be shared.

Identify the data you wish to use

We describe our various datasets on this page [LINK]. The descriptions are public and necessarily fairly high level. We do however try to indicate the size of the datasets, the period over which they was collected, along with any known biases.

We strongly enourage the use of prepacked datasets rather than "live feeds". Although a live feed may be superficially attractive it makes it harder to arrange that other researchers can receive the same data that you did -- a key aim of the Cybercrime Centre is to enable reproducible research. If the issue is that you need to collect a further "field" over and above what we supply then talk with us and we may well be able to do this for you.

Read about our legal framework

It is important that you understand the basis on which we share data and the paperwork that will need to be signed.

There's several pages of explanations and FAQs about our agreements, starting here at https://www.cambridgecybercrime.uk/data.html, which you should read before contacting us.

Make an application

You will need to make a formal application to use our data. In the first instance you should send an email to the Director of the Cybercrime Centre,

Ransomware

- Executing a program on your machine encrypts your data, and you must pay for the decryption key to get your data back
- AIDS Trojan 1989 (arrived on a 5.25” disk!)
- Academic work on using public key dates from 1996
- Various attacks in 2005/2006
- First big success in 2013 with cryptolocker
  - requested payment in bitcoin (trying to avoid “follow the money”)
  - criminals put a lot of effort into customer support
  - lots of people paid up and almost all got their data back
- Now lots of variants, and lots of spam containing it
  - and some doesn’t work properly so can never decrypt
  - and some is badly designed (check out: nomoreransom.org)

Ransomware avoidance

- Use sophisticated anti-spam systems
  - your copy of SpamAssassin isn't good enough any more
- Run anti-virus
  - the problem is that criminals don't ship the malware until it evades AV, so this only works if you answer your email very slowly
- Don't click on attachments
  - training can help by reducing the number of people who open malicious attachments (not everyone understands the risk)
- Don't give everyone write access to every "share"
  - ransomware cannot encrypt what it cannot write
- Don't expose your database online
  - problems are occurring with MongoDB, MySQL etc
  - automated scanning means that unlikely just one encryption!

Practical thinking about ransomware

- Ransomware is just a Business Continuity Issue
  - same threat as a cup of coffee
  - same threat as a rogue employee
  - same threat as a burning building
  - same threat as a flooded datacentre
- Asking people not to click isn’t going to work
  - but do they need Word on the system ?
  - But do they need scripting enabled in PDFs ?
- The real fix is backups
  - which must not be writeable except when backing up!
  - preferably offsite
- Backups need to be tested and restore needs to be practised
  - even with backups it may take days to recover

Business Email Compromise (BEC)

- Several different types of attack
- Fake Invoice
  - email system compromised
  - replacement invoice issued with criminal's details
  - usually involves a "look alike" domain
    - arnazon.com, qotocopenhaqen.de, netvvorksolutions.com
- CEO fraud
  - please pay this supplier, I forgot before I left for the conference
    - don't ring, I'm in sessions all morning
    - lookalike domains here too (or verysimilar@webmailsystem.com)
- Can involve significant losses
  - $3m for a boatload of coal
  - $1m for a shipment of palm oil
    - FBI says $26 billion worldwide from June 2016 to July 2019

BEC avoidance

- Check incoming email for look-alike domains
- Apply DMARC tests
  - i.e. check for SPF or DKIM passes
- Flag email where reply-to and from are different
- Set your email client to display <the@address.string>
  - major email clients rethinking this issue
  - still a problem on mobile
- Label email coming from outside the company
- Use S/MIME or PGP to validate email

Practical thinking about BEC

- Agree on bank account details up front
  - change contract to specify bank details not “as nominated”
  - agree at the start of your house purchase what accounts to use
- Don’t accept changes to payment destinations by email
  - insist all changes are made by snail mail, personal visit
- If a change is being made by email check it “out of band”
  - NB: use the phone number from the filing cabinet not the email !
- Share stories with your peers (& at dinner parties)
  - this type of fraud is not as well-known as it should be
- Empower your accounts department to say “NO”
  - No Purchase Order, No Payment!
  - pay a bonus for standing up to the fake CEO (and the real one)

Gift card scams

- Related to BEC (and sometimes included with it)
- Your CEO asks you to buy some gift cards:
  - for a staff bonus
  - for rewarding customers
- You are then asked to scratch off the numbers and send a photograph to “the CEO”
- Unclear that the real CEO is going to reward you for your acquiescence, so you may be personally out of pocket

Practical thinking about gift card scams

- If you are a CEO
  - tell your staff you just aren't going to do this
- If you are a member of staff
  - think more clearly about what you are about to do

- Will training help ?
  - evidence for substantial changes in behaviour limited
  - sets staff against the IT Department (Sasse/Murdoch)
  - test results are easy to skew (up or down)
- A lot to be said for telling stories round the camp fire…

Sextortion

Subject: richard@highwayman.com:abcdef
From: "Mallory" <important>
To: richard@highwayman.com

It appears that, (abcdef), is your password. Will possibly not know me and you are probably wondering why you're getting this e mail, right? in fact, I setup a malware on the adult vids (porno) website and you know what, you visited this website to have fun (you really know what I am talking about). During the time you were watching videos, your internet browser started out operating as a RDP (Remote Desktop) which provided me accessibility of your screen and webcam. after that, my computer software obtained your entire contacts from the Messenger, Microsoft outlook, Facebook, in addition to emails.

What did I actually do? I made a double-screen video clip. First part shows the video you're seeing (you have a good taste haha . . .), and 2nd part shows the recording of your webcam.

what exactly should you do?

Well, in my opinion, $1000 is a reasonable price for our little secret. You'll make the payment by
Bitcoin (if you don't know this, search "how to buy bitcoin" search engines like google).
Bitcoin Address: 1GMC81t4GRgK9C1UwqSrtfDSaeHJics62q
(It's case sensitive, so copy and paste it)

Very important:
You have one day in order to make the payment. (I have a unique pixel in this e-mail, and at this moment I am aware that you've read through this email message). If I don't get the BitCoins, I will certainly send out your videos to all of your contacts including relatives, coworkers, and so on.Having said that, if I receive the payment, I'll destroy the video immidiately. If you need evidence, reply with "Yes!" and i'll certainly send your videos to your 6 contacts. It is a non-negotiable offer, that being said don't waste my personal time and yours by answering this message.

Popularity due to Brian Krebs!

- July 18th mentions the innovation of supplying password
  - now appears these mainly came from LinkedIn 2012 hack
- Comments list a few more examples (with bitcoin wallets)
- August 18th Krebs revisits the story … adds up proceeds
  - $100K paid in previous 2 weeks !
- Krebs also reported another analysis:
  - 150 victims, $250K paid!
- After that sextortion became extremely common
  - I have examples in German, French, Japanese, Korean, Thai

Sextortion enhancements

- I sent this from your email address
  - playing on ease of forging “From: “ (and indeed MAIL FROM)
- Detailed explanation of why changing password ineffective
  - malware is still on your machine
- It’s worth stressing that almost all of the technology described in sextortion emails is capable of being constructed
  - so keep your browser fully patched when visiting the shady side of town, keep Flash turned off and don’t install special viewers
- Only weakness is that extortionists cannot provide a sample of the video they claim to have made
  - so perhaps next iteration will involve faking still images ?

Practical thinking over sextortion

- The emails have been remarkably easy to block as spam
  - bitcoin address is easy to parse for
  - but recent examples have split wallet address over two lines
- Best advice is to search for the text in the email and that way you can see if it has been received by others
  - this will help you with a wide range of fraudulent email
    - your brand is being registered under .asia
    - you are qualified to live and work in Canada
    - you have been caught on a traffic camera
    - etc. etc.
    - (even would you like to be in a Facebook focus group next week?)

Passwords – the brute force analysis

- A safe is protected by a 4 digit code
  - so there are 10000 possible combinations
  - 10 to the power of 4
- How long until you open it ?
  - you might crack it at your first try
  - you might crack it after 9999 failures
  - on average it will take 5000 attempts
  - at 10 seconds per attempt it will take over 13 hours (on average)
- If 6 digits then 100 times longer (10^6 = over 8 weeks)
- If 4 alpha characters (A..Z) cracking time is over 26 days
- … and for 6 alpha characters it's 49 years
- If eight characters from A..Z a..z 0..9 then 62^8 = 34m years

Computer passwords

- Computer will compare password from user with stored secret
  - obvious risk if hold passwords in plain text
    - but you can send really good "reminders"
- Needham & Guy (1963) proposed 1-way hash
  - store Hash(secret)
  - hash user value and check for exact match
- Unix hash (from 1991) was 25 rounds of DES
  - more recently we use MD5, SHA-1, SHA-256 &c
- Reversing the one-way hashes is "impossible"
- But computers (& GPUs) are fast so "brute force" attack…
  - NVIDIA GeForce 8800 Ultra: 200m MD5's per second
  - so length 8 of A..Z falls in 8 minutes
  - so length 8 of A..Z a..z 0..9 falls in 6.3 days

Parallel cracking

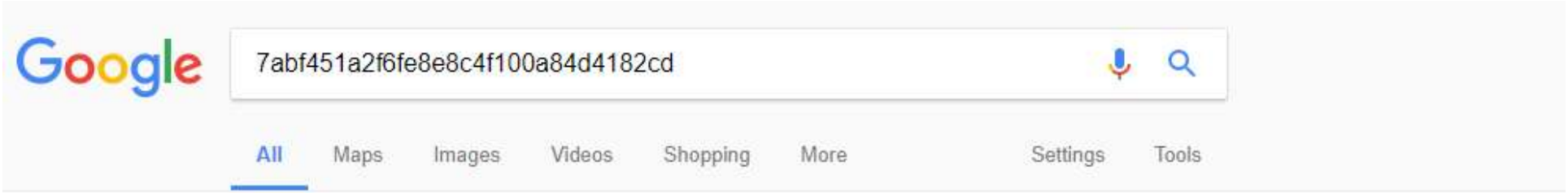
- Easy to parallelise cracking tasks
  - split search n ways amongst n machines
  - dish out task blocks to these machines
  - good when machines different speeds
  - can all do a random search (this avoids communication costs and is tolerant of cheating)
- Hence usual metric is to consider number of hashes per dollar
- Alternatively one can try small number of passwords against many accounts
  - it may not matter which password is cracked, just how many
  - perhaps just one is sufficient [cf DirtyCow])

Real world hash cracking

- R!chard1

  MD5(R!chard1)

  7abf451a2f6fe8e8c4f100a84d4182cd



5 results (0.30 seconds)

View a hash - MD5DB | The MD5 Database

https://md5db.net/view/7abf451a2f6fe8e8c4f100a84d4182cd

Hash, **7abf451a2f6fe8e8c4f100a84d4182cd**. Word, R!chard1. View. You can use our API : https://md5db.net/api/**7abf451a2f6fe8e8c4f100a84d4182cd**.

MD5 hashes starting with "7ABF" - MD5DB | The MD5 Database

https://md5db.net/explore/7ABF

4735, **7abf451a2f6fe8e8c4f100a84d4182cd**, R!chard1. 4736, 7abf451c826...52ba28e0831272ad2ebe9, zs$ZFA. 4737, 7abf4520b8ff...5cf93c537d8beba715 ...

7abf - Hash Killer

hash-killer.com/dict/7/a/b/f

... 2dda4a 7abf44ed64315dd08a70ffec66685891 high-soundingwords 7abf44f5ec3937c3fcc113122c8b68c2 j8PWYeH6 **7abf451a2f6fe8e8c4f100a84d4182cd** ...

HASHHACK - MD5 decrypt

https://hashhack.pro/explore.php?section=0&page=5282 Translate this page

... R!ch@rdW64:f659b1e2f6d6116cb117614f17869f5a | R!chard1:**7abf451a2f6fe8e8c4f100a84d4182cd** R!chardson:1ec881bf184d578bf7da14ef53f57a7e ...

HASHHACK - MD5 decrypt

hashhack.pro/dict.php?block=7abf

7abf451a2f6fe8e8c4f100a84d4182cd:R!chard1 7abf45235d2de73f612c564b12f80252:Blikschaar! 7abf453cf9b3cf2124329d9570106c55:0047568 ...

Modern protection: salts & slow hashes

- Internet has many sites with hashes
  - the sets of tables are sometimes (incorrectly) called rainbow tables
  - see (e.g.) Wikipedia for details of how rainbow tables actually work
- To protect against hash tables (and rainbow tables) passwords are usually "salted" with a random value chosen by the system
  - calculate hash(salt_value | password_text)
  - now attacker needs 2^s tables for each password (for s bits in salt)
  - salt is stored *en claire* next to the hashed password
- Modern trend is towards hash functions designed to be slow to run on GPUs and ASICs
  - generally achieved by writing & reading lots of memory.
  - these hashes also tend to be tuneable (you select the number of iterations to provide the performance you need)
  - e.g. bcrypt, Argon2i

Practical thinking about passwords

- General Principle: you cannot assess a security solution without first determining what your "threat model" might be
- Are attackers Online or Offline ?
  - can attacker steal file and then do their cracking on their own kit ?
  - or do attackers have to present all their guesses to your systems ?
- Are attacks Targeted or Untargeted ?
  - does the attacker win if they crack one specific password, a percentage of passwords, or any password at all ?
- How much can you impose on your users
  - password length, character sets, system-chosen passwords?
- Are attackers local or remote
  - is writing down a password a disaster or somewhat desirable ?
- Why can't I deploy a two-factor solution ?

Current advice on passwords

- Advice from NIST (2017: 800-63B) on passwords
  - pay attention to length, not to character sets
- Change passwords only when compromise suspected
  - change rules usually imposed by auditors and not evidence based
  - in practice humans “cheat”
    - verysecret1, verysecret2, verysecret3…
    - Secret!Jan, Secret!Feb, Secret!Mar
- For offline attacks limit is size of attacker’s wallet
- Online, the system can set the limits, so make sure it does
  - <n> tries and then a timeout
    - better is that tries get exponentially slower (e.g. iPhone)
  - limits need to be
    - per account : one account being attacked
    - per IP: stop attacks on n accounts in parallel

What criminals do

- Given a password file, criminals brute force the passwords
  - if not encrypted then of course trivial
  - if not salted then may be just a lookup
  - otherwise use mangled dictionary approach
    - Passw0rd, pa$$word, Password, Password1
- Then they try the username/password combination everywhere
  - so after a merchant compromise they can attack email accounts, Skype, banking, Facebook etc etc
- Good guys are also brute force the passwords
  - force password change on users as needed
  - perhaps prevent future use of this password
- Around 90% of the 2012 Linkedin password leak were broken !
  - so file theft => all users must be assumed to be compromised

Some inconvenient truths

- Note that an incorrect password (or two) followed by the correct one is often a good indication of it being authorised human !
- Passwords that are always correct come from mobile phones!
- Passwords that are always incorrect come from mobile phones!
- Need to balance barring the bad guy with the risk of them perpetrating a denial of service attack on the account's legitimate owner
- Malware keyloggers…. game over!
- Compromise of clear text password file…. Game over!
  - and remember that 90% figure from LinkedIn
- Password managers are a good way forward, but they have a chequered history regarding their own security

Summary

- Cambridge Cybercrime Centre
  - driving a step change in cybercrime research in many disciplines
- Ransomware is merely a Business Continuity Issue
  - back up your data & practice restoring it
- Business Email Compromise is addressed by following procedures and empowering your accounts department
- Sextortion emails should be ignored
- Passwords should be hashed and salted
  - and changed only when needed
- User should use long passwords, and not reuse their email or banking password elsewhere
  - complexity is a red herring, pay attention to attack techniques

blog: https://www.lightbluetouchpaper.org

Cambridge Cybercrime Centre

data: https://cambridgecybercrime.uk

UNIVERSITY OF CAMBRIDGE
Computer Laboratory