ERNW
providing security.

Hands-On BloodHound

BruCon 2019

@SadProcessor

Agenda

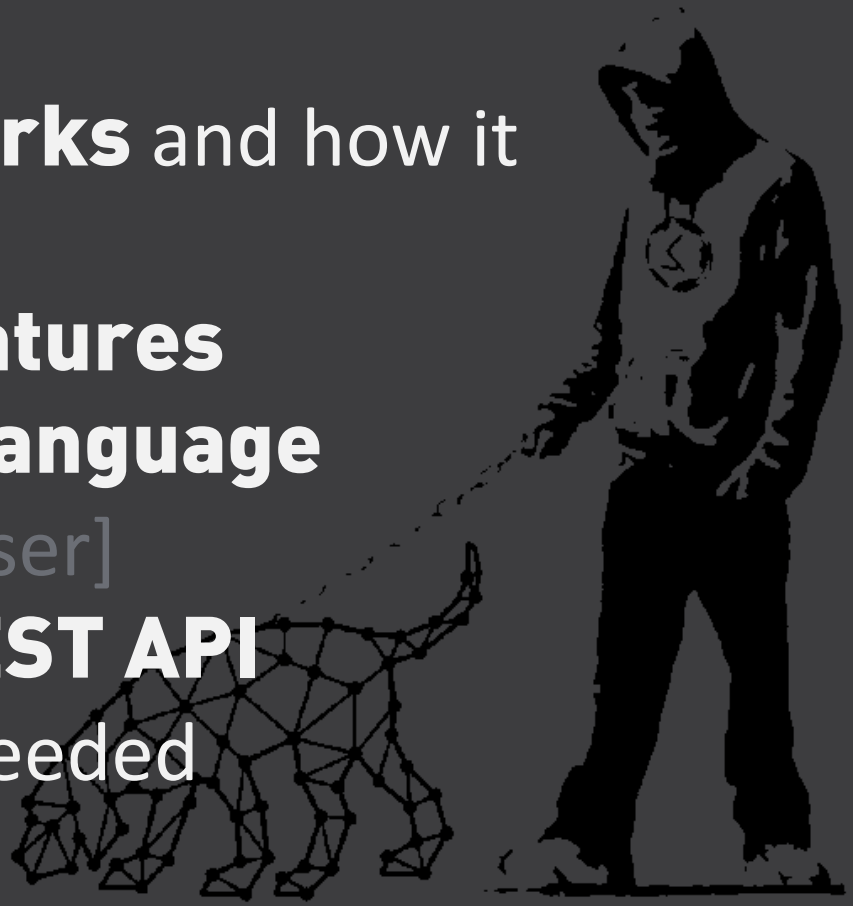
- BloodHound? Wut?
- Data & Collection
- Cypher - Basics
- Cypher - Advanced
- REST API & Automation

And memes…

Goal

At the end of this session, you should

- Understand **how BloodHound works** and how it could be useful for you [Red/Blue]
- Feel familiar with the **UI & tool features**
- Understand the basics of **Cypher language**
- **Create/Debug queries** [UI/Browser]
- Understand the workings of the **REST API**
- Know where to find **Info/Help** if needed



Prereq & Scope

If you want to follow along during the workshop

- Please **install BloodHound** BEFORE the session

[Due to time constrained this will NOT be done during session]

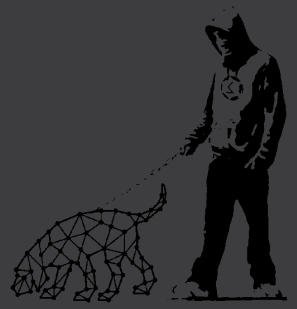
This training is about **Bloodhound & Cypher**, the following topics will not be covered in this workshop:

- Active Directory & Hardening in General
- Specific Attack Scenario

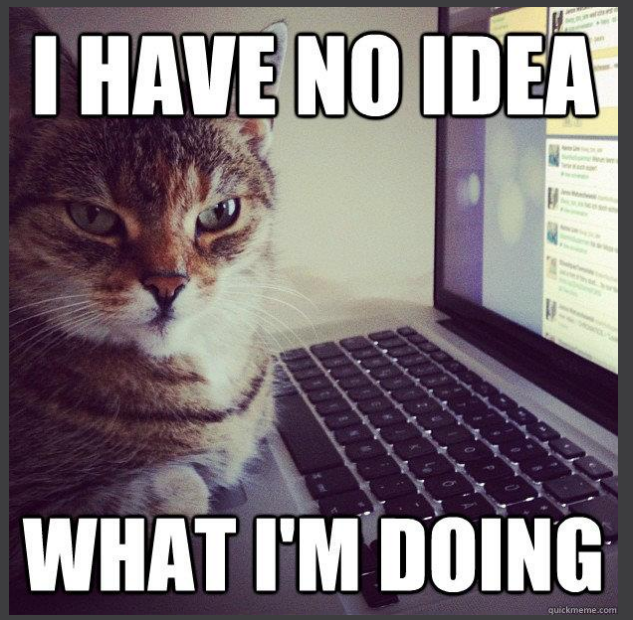
Whois

Walter Legowski - @SadProcessor

- Windows Security Consultant [ERNW]
- Born FR, Live NL, Work DE
- Like Buildings/Windows/Backdoors
- Like Cats/Trees/Backstreets
- Don't like Dogs
- Made exception for **BloodHound**

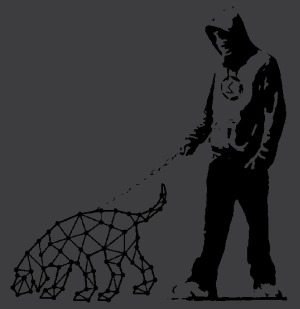


Disclaimer



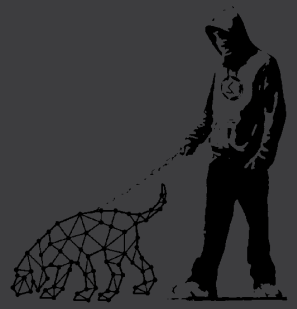
- **I am not a Cypher expert** [I'm a Cat]
- Training only scratches the surface
- Excuses if any errors/typos in my slides

- **DO NOT SCAN A CORPORATE NETWORK WITHOUT PROPER AUTHORISATION**



Ready?

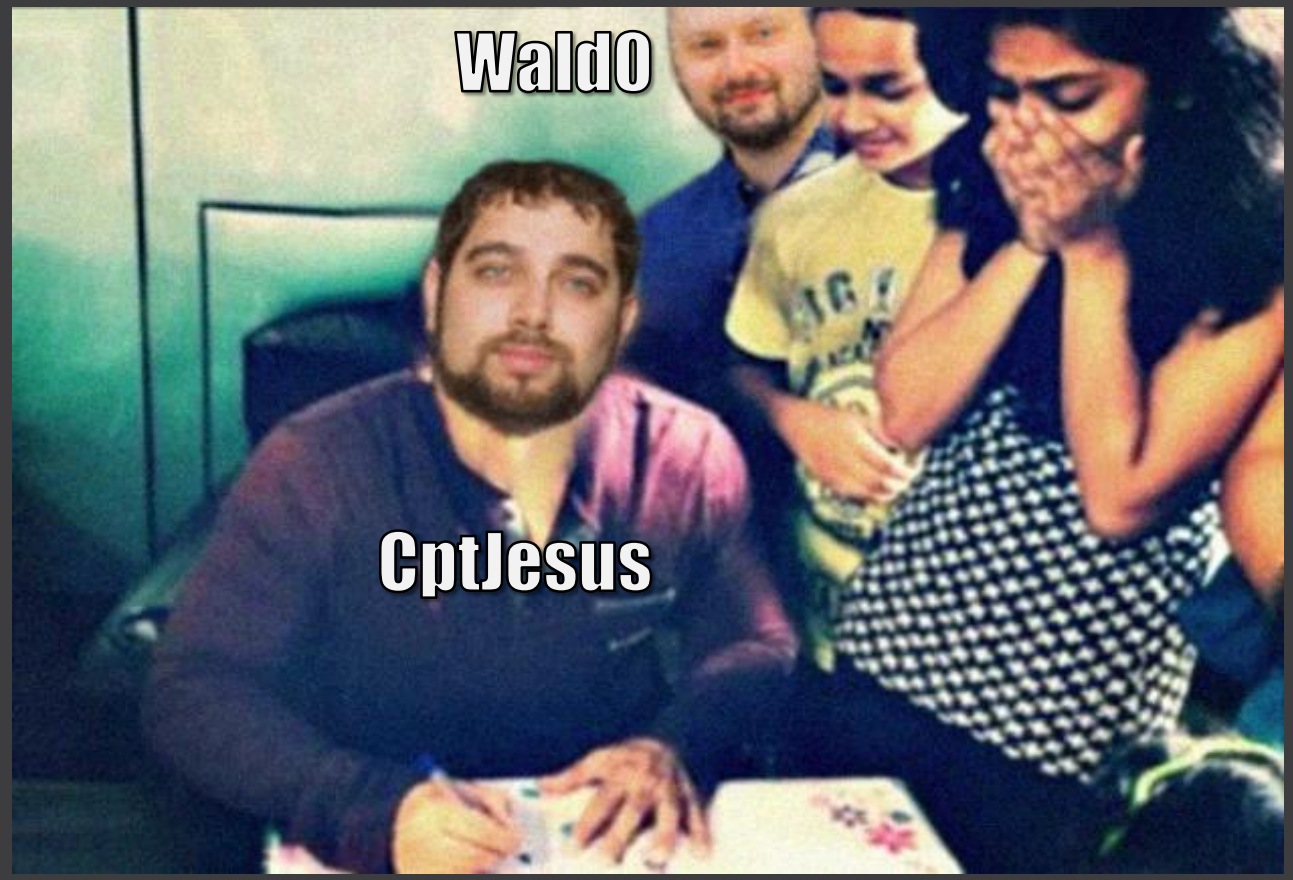
Let's Go...



1- BloodHound? Wut?

- Who?
- What?
- Why?
- Where?
- How?

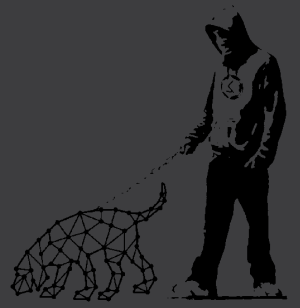
BloodHound - Who?



Created by

- @_WaldO
- @CptJesus
- @harmj0y

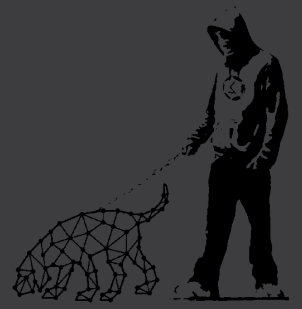
[click follow...]



BloodHound - What?

Defenders think in lists,
Attackers think in graphs,
As long as this is true,
Attackers win...
[John Lambert, MS Threat Intel]

Read: https://blogs.technet.microsoft.com/johnla/2015/04/26/defenders-think-in-lists-attackers-think-in-graphs-as-long-as-this-is-true-attackers-win/

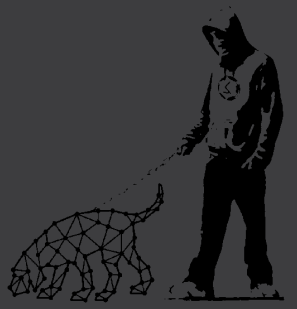


BloodHound - What?

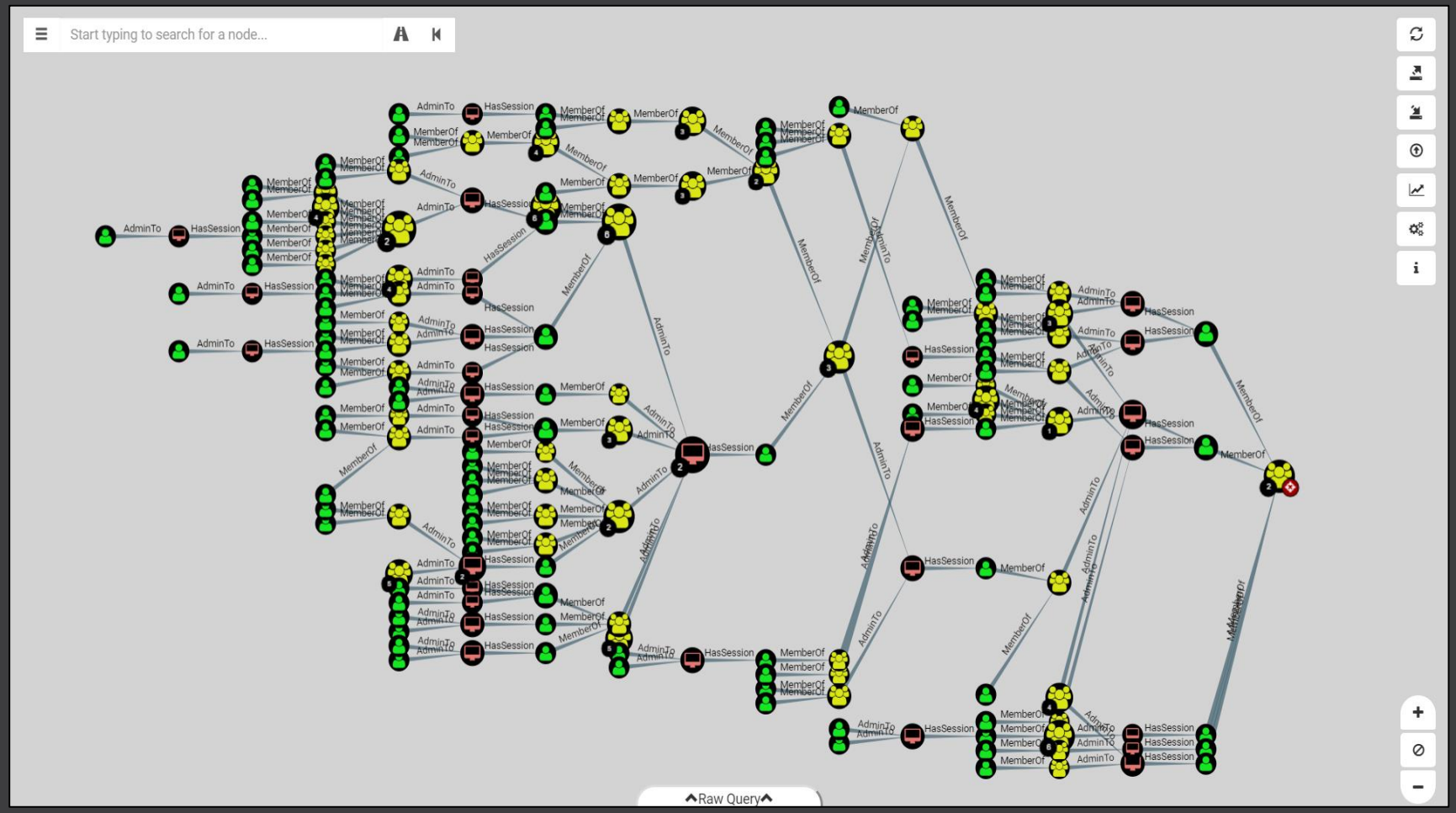
An **AD Attack Path Mapping Tool**, originally designed for **Post-Exploitation**, and useful for **AD Hardening** in general...

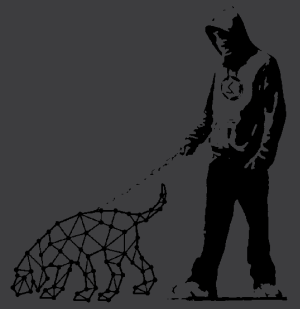
Collects and **graphs** relationships between **AD** Objects, and helps discover **security weaknesses**.

Code: https://github.com/BloodHoundAD/BloodHound

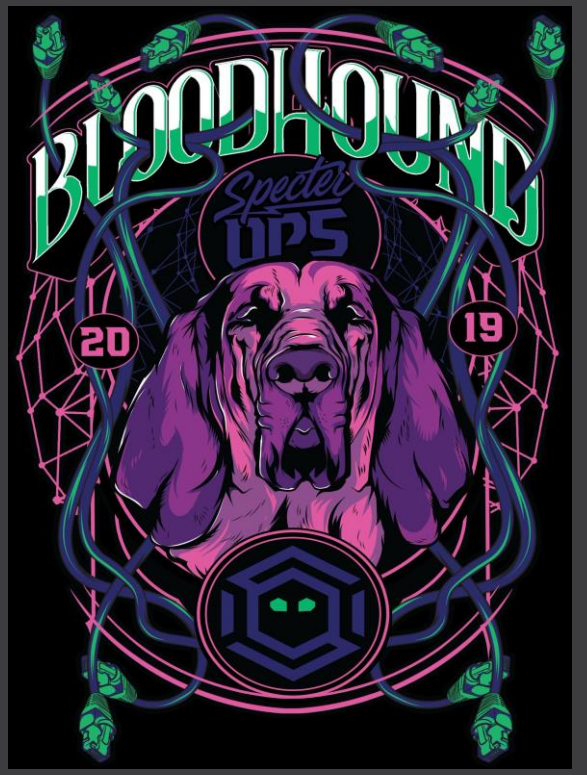


BloodHound - What?



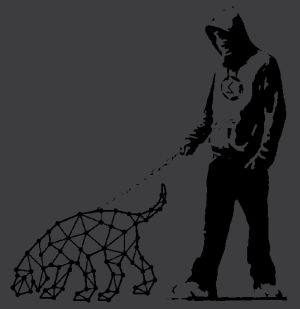


BloodHound - What?



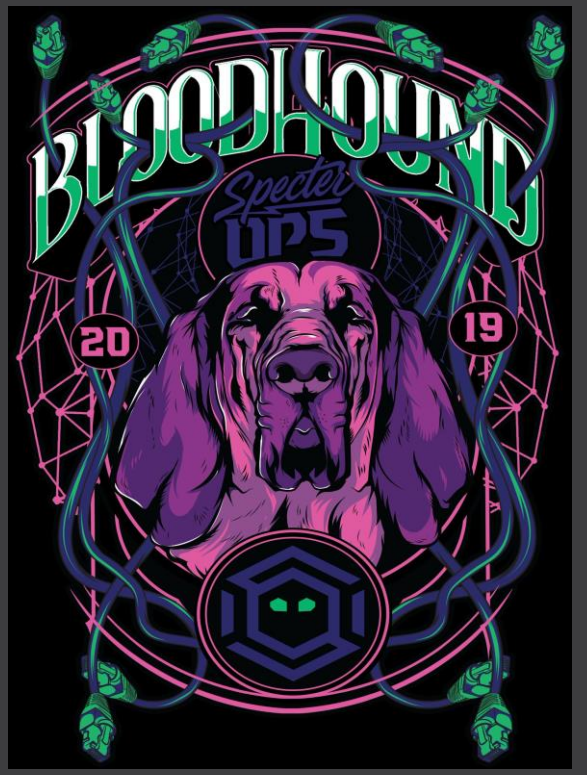
An **AD attack path** mapping tool...

- **Open Source** [all OS flavor]
- Based on **neo4j** graph DB
- Initial release: 2016
- Current version: 2.2
- Well maintained & documented
- User Community ++



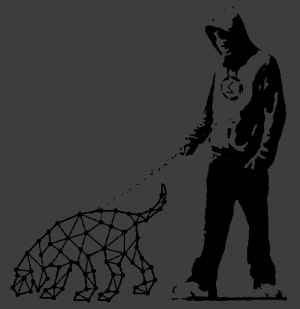
Wiki: https://github.com/BloodHoundAD/BloodHound/wiki

BloodHound - What?



An **AD Hardening** tool...

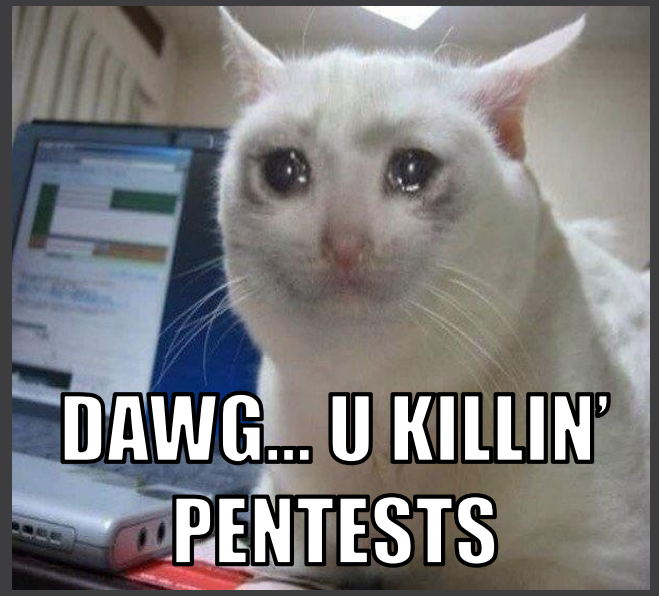
- Originally designed for **Red Team** reconnaissance [Post-Expoitation]
- Gaining popularity in **Blue Teams**
- Can be used for Security **Consulting** and **AD Auditing**
- **Expandable** & **Automatable**

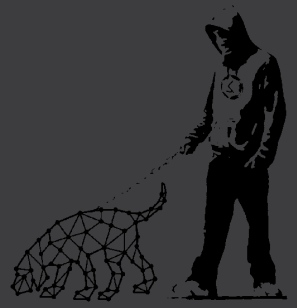


Wiki: https://github.com/BloodHoundAD/BloodHound/wiki

BloodHound - Why?

- **RED**: Find Path to Attack
  [Report > Blue > Consultant > Fix]
- **BLUE**: Find Paths to Defend
  [Report > Consultant > Fix]
- **CONSULTANT**: Find MisConfigs
  [Fix > Report]





BloodHound - Where?

Tool & Resources...

- Neo4j Community Edition

https://neo4j.com/download-center/#community

- BloodHound Source code

https://github.com/BloodHoundAD/BloodHound

- BloodHound Wiki

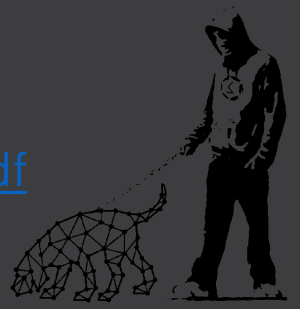
https://github.com/BloodHoundAD/BloodHound/wiki

- Neo4j Cypher Reference Card

https://neo4j.com/docs/cypher-refcard/current/

- Dog Whisperer Handbook

https://www.ernw.de/download/BloodHoundWorkshop/ERNW_DogWhispererHandbook.pdf

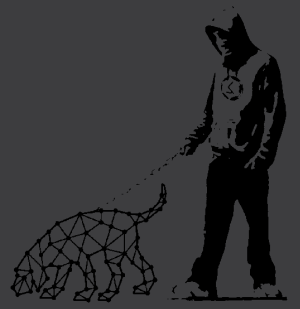


BloodHound - How?

Install... [Windows64]

- [Install Java64bit]
- Unzip Neo4j Community Edition
- Install & Start neo4j service
- Go to **http://localhost:7474**
- Set new password
- Unzip BloodHound Source
- Start bloodhound.exe & enter password

Wiki: https://github.com/BloodHoundAD/BloodHound/wiki/Getting-started



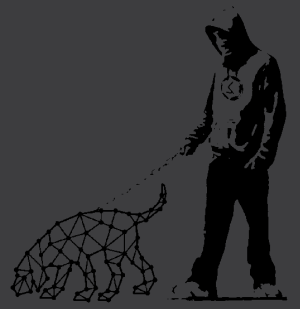
BloodHound - More

Get yourself on the BloodHound Slack

- Read tons of **interesting stuff**
- Meet tons of **interesting people** [4500+]
- Ask Wald0 about **#cypher_queries**
- Speak **#kerberos** with Harmj0y
- Ask Jesus **#random things**
- Hate @PrimaryTyler,CISSP as you like

And more…

Invite: https://bloodhoundgang.herokuapp.com/

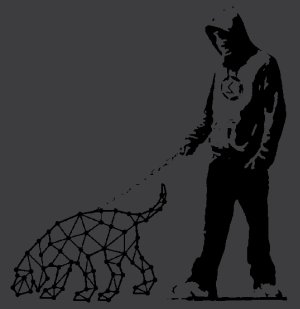


Hands-On: Slack

Join the Gang... [only if you like ofc]

- Invite yourself to the BloodHound Slack
- Check out some channels
- Join a few of your choosing

- Bonus:
  Ask @CptJesus for an autograph in #bloodhound-chat
  [or hate @PrimaryTyler,CISSP in his dedicated channel]
  and win a BloodHound sticker!!

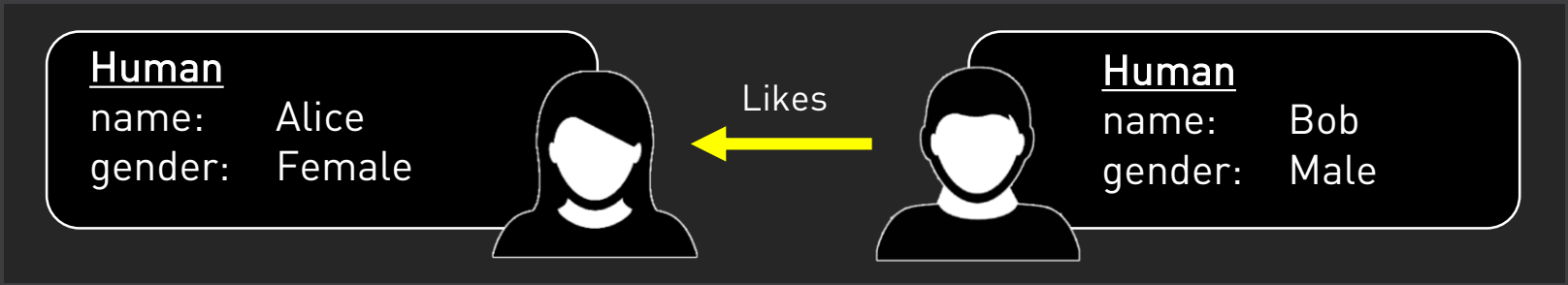


Invite: https://bloodhoundgang.herokuapp.com/

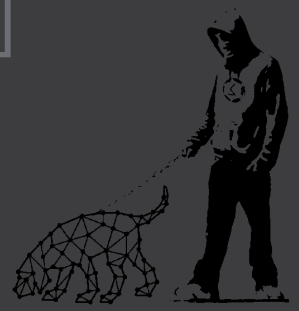
2- Data & Collection

- Alice & Bob
- BloodHound Data
- SharpHounds
- Collection Methods
- Data Import

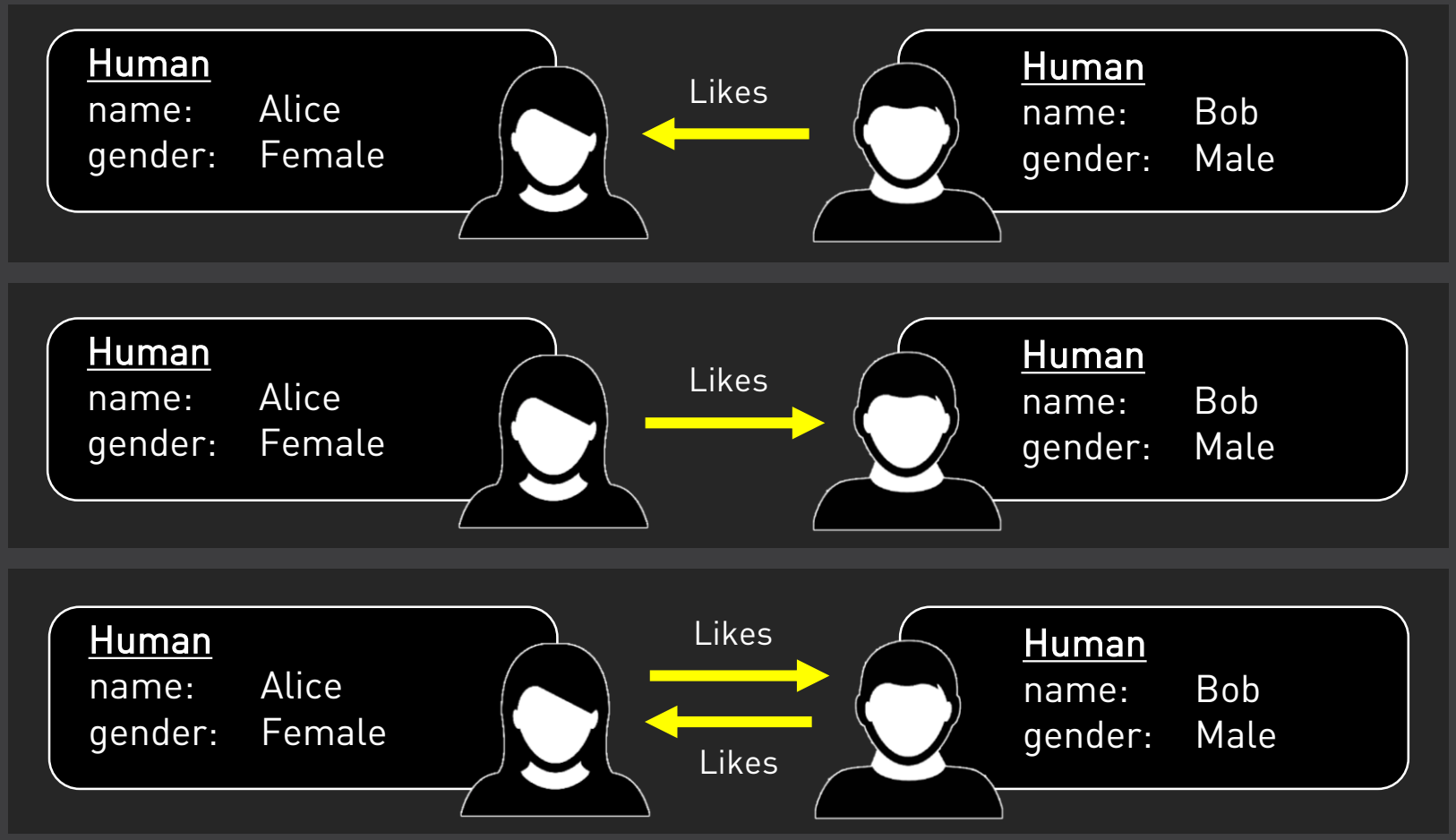
Alice & Bob - Terminology



- Objects are called **Nodes** [Humans Alice & Bob]
- Nodes have a type aka **Label** [Human]
- Nodes have **properties** [name/gender]
- Relationships are called an **Edges** [Likes]
- Edges can also have properties

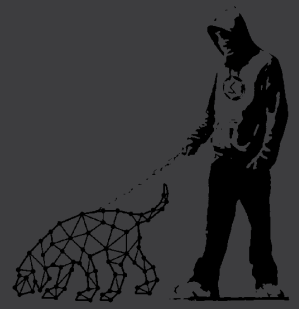


Alice & Bob - Terminology

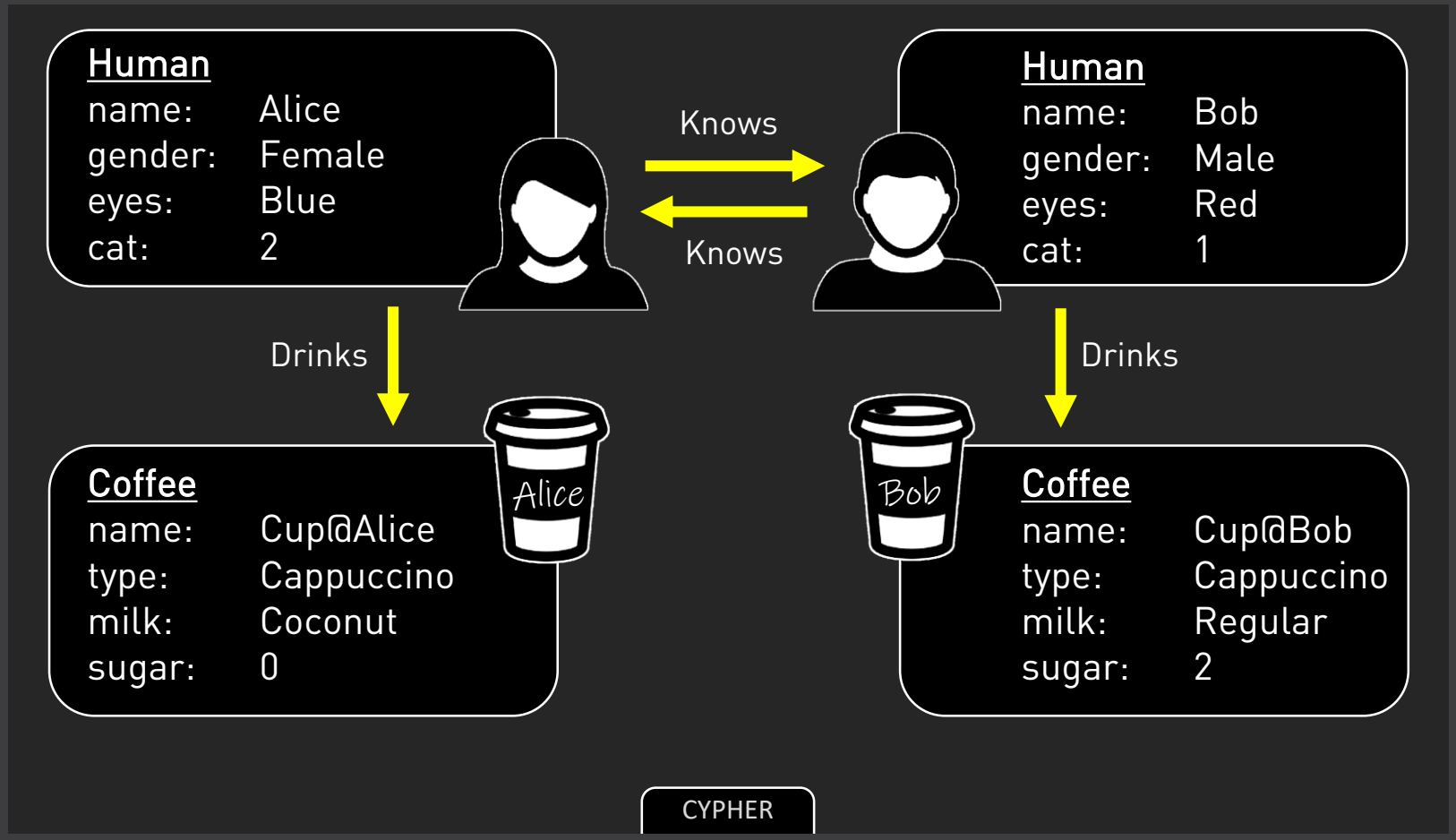


Important:
Edges are directional

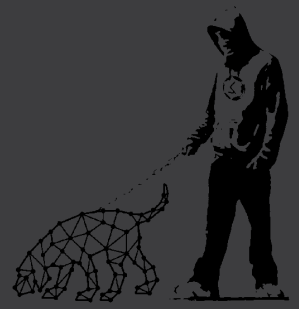
[Need two Edges for relationship to go both ways...]



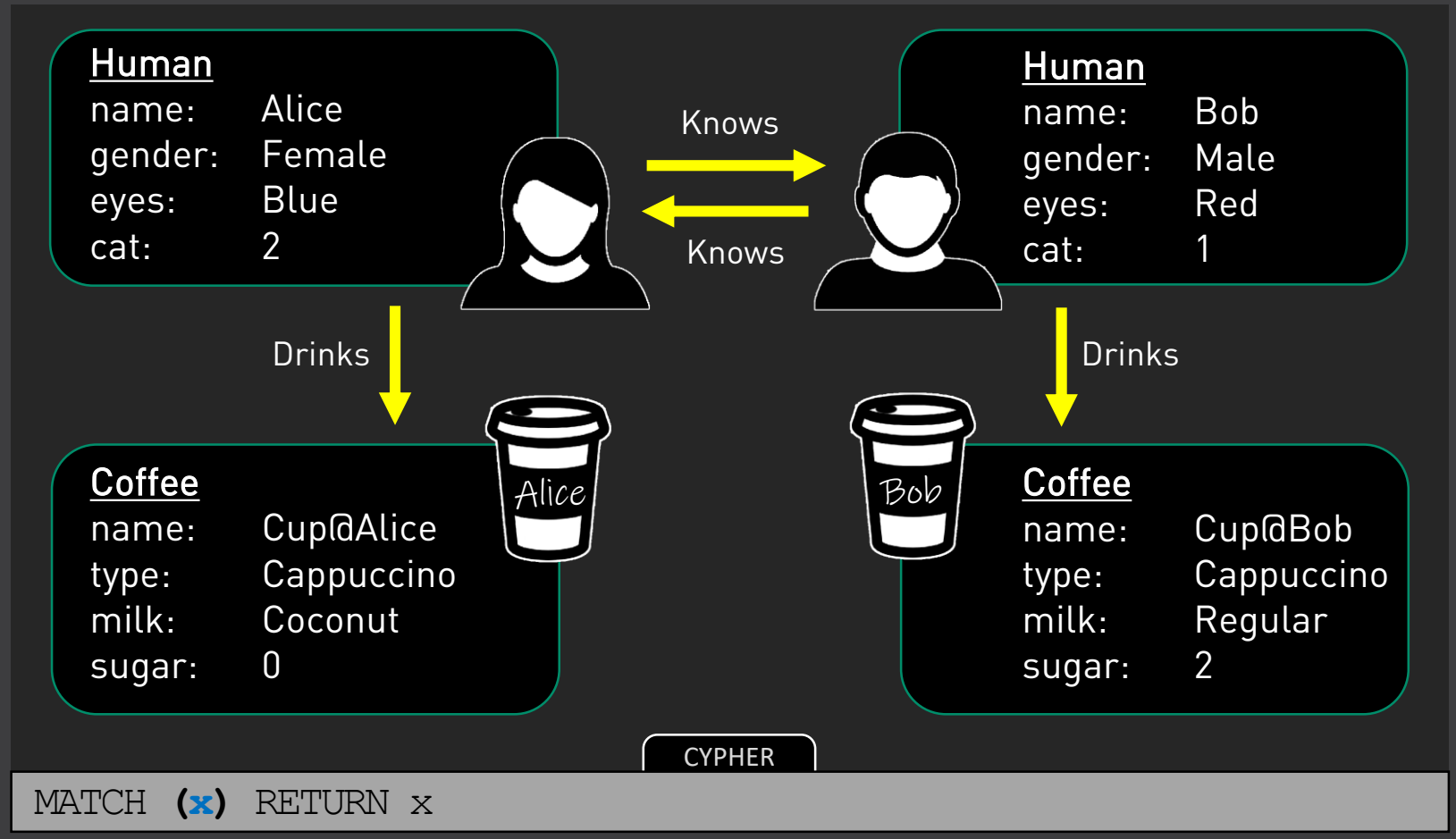
Alice & Bob - Dataset



Now let's imagine this is our data. **Let's see what we can ask neo4j...**

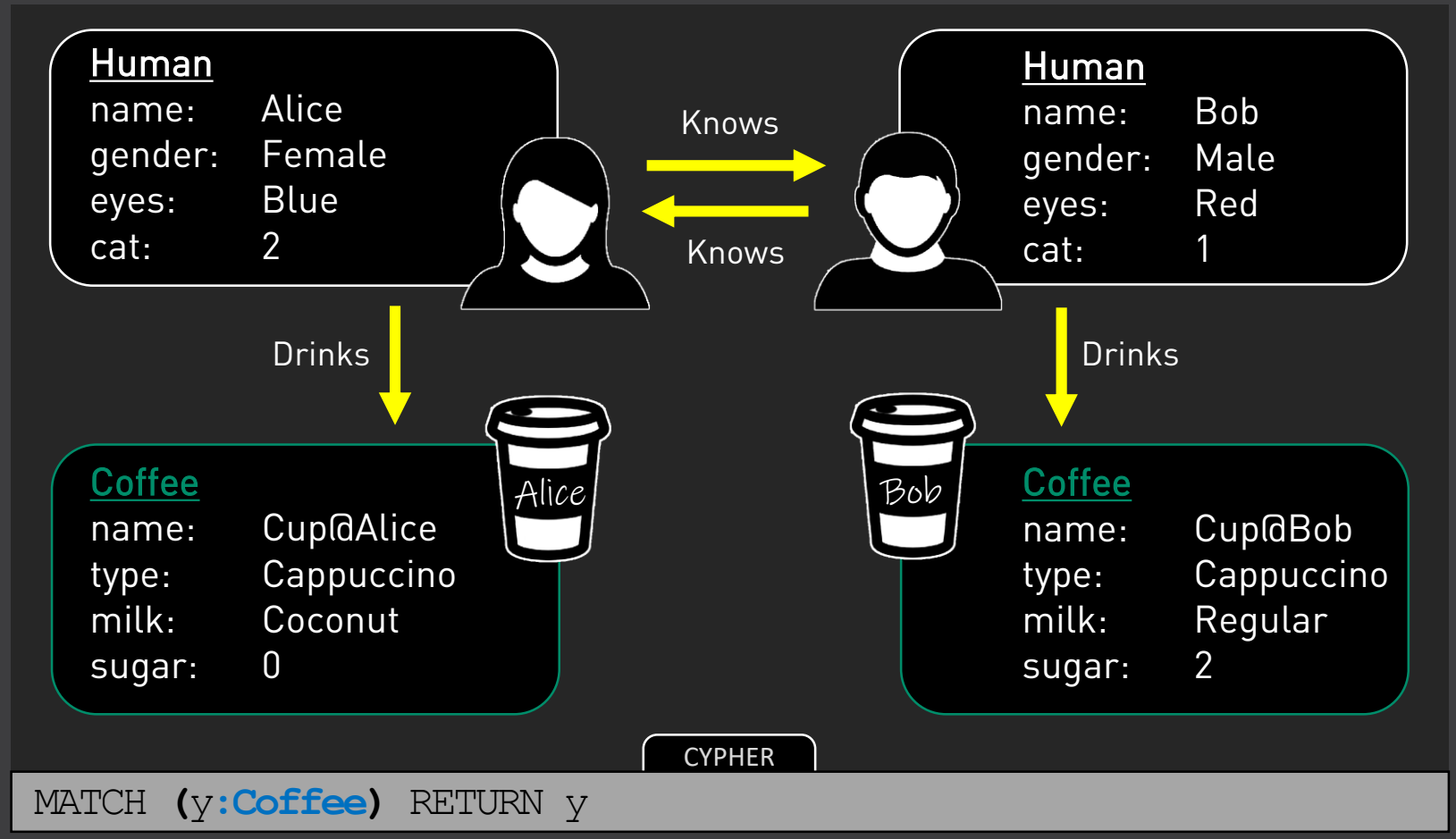


Alice & Bob - Queries

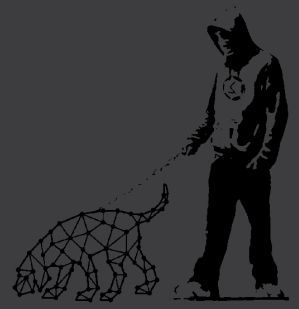


Return all Objects... [Nodes]

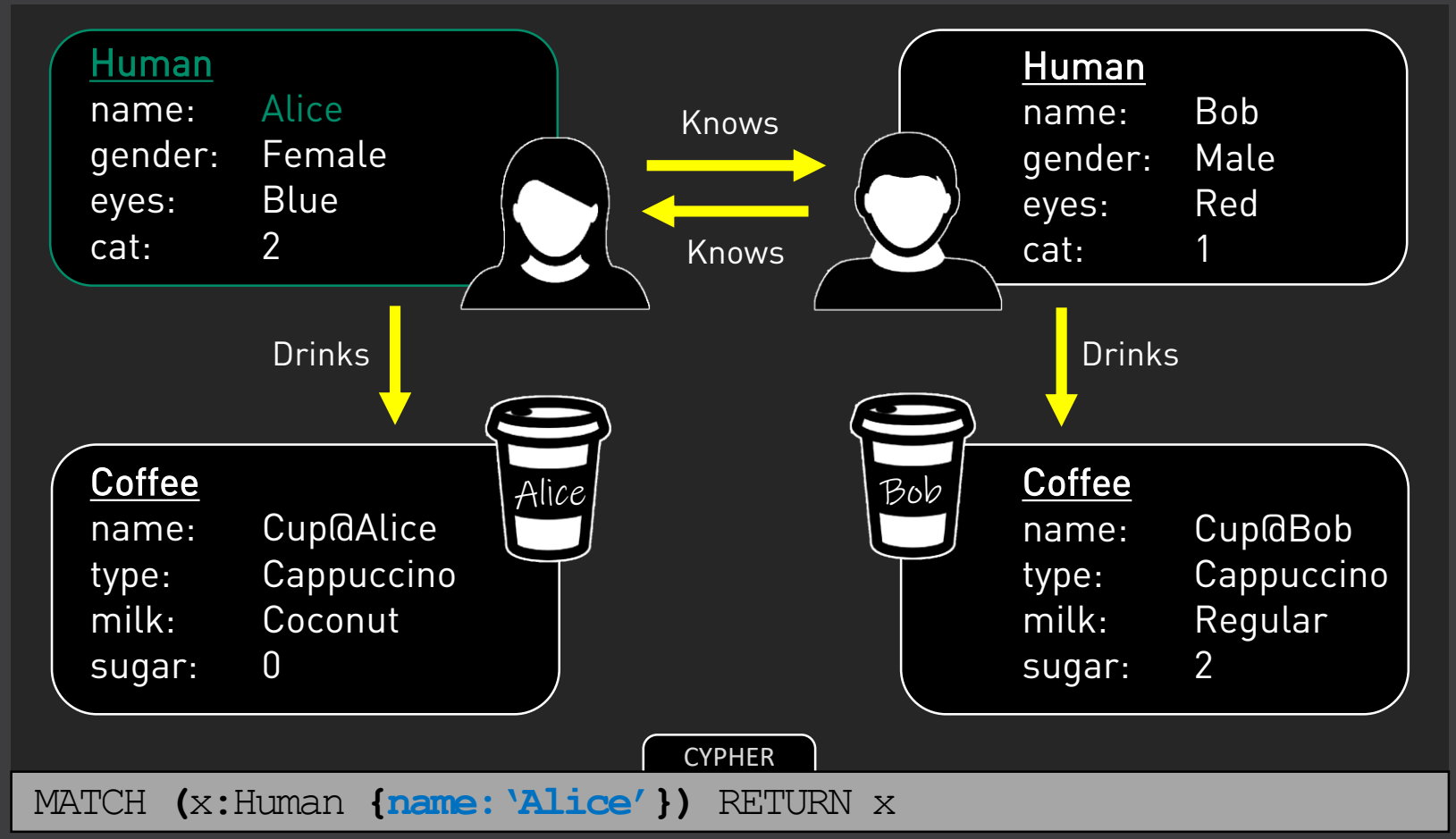
Alice & Bob - Queries



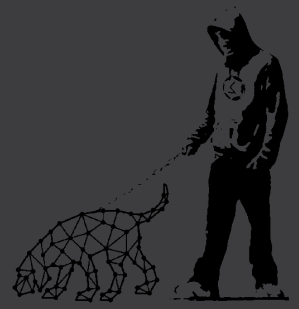
Return all Nodes of type Coffee [Label]



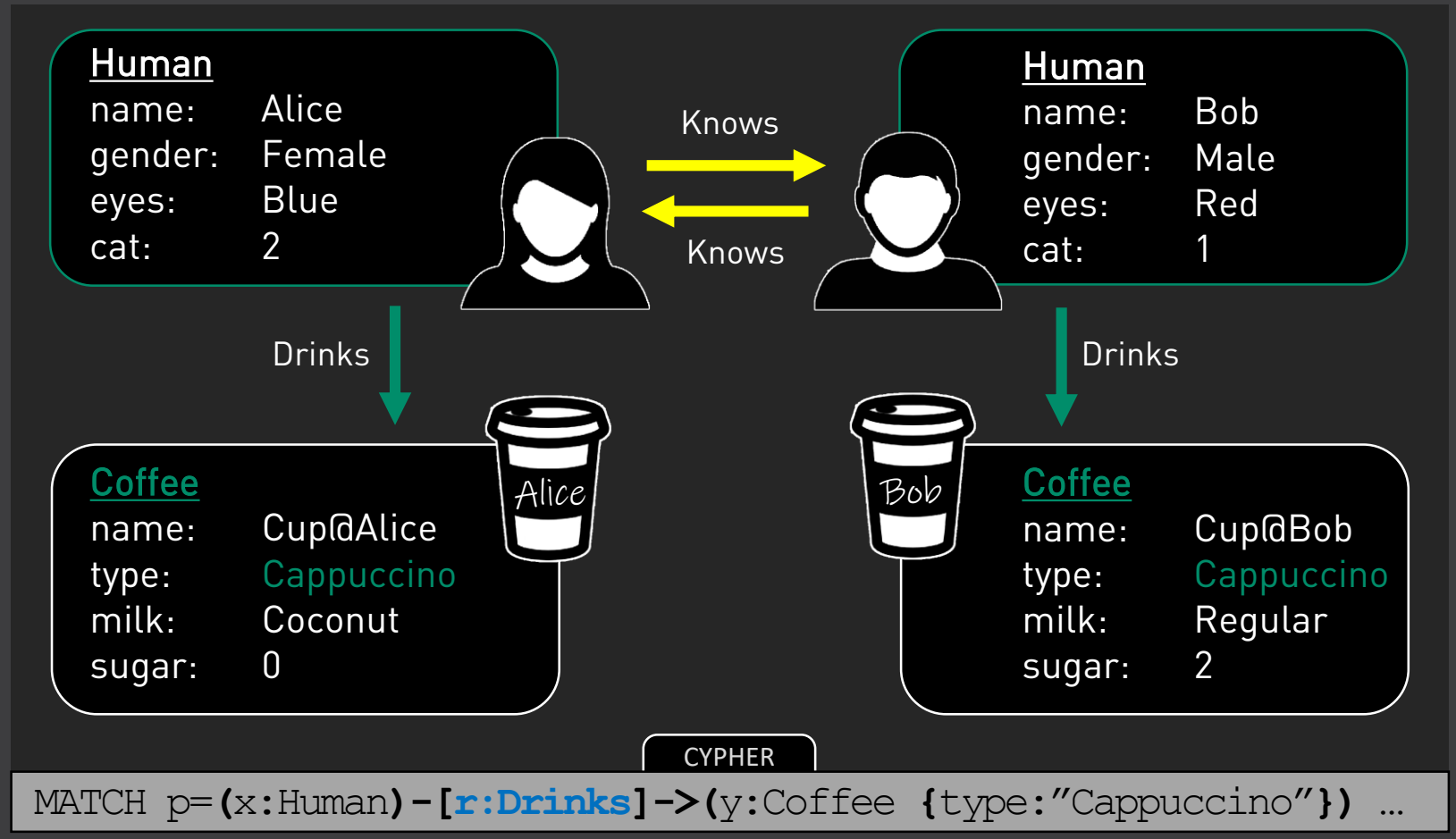
Alice & Bob - Queries



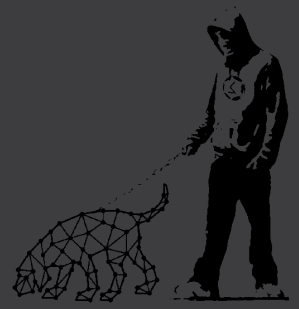
Is there a Human with name Alice?
[Property]



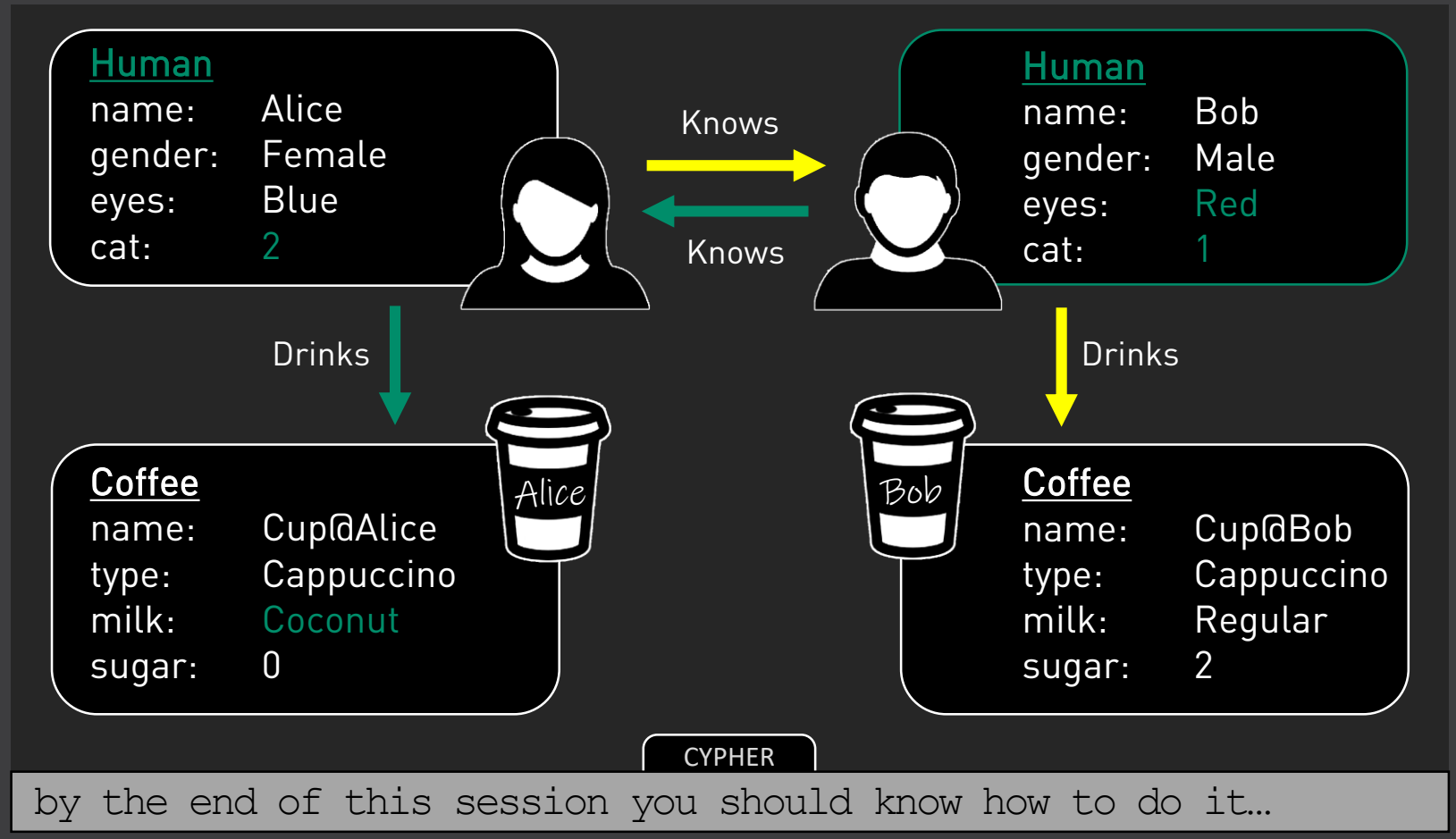
Alice & Bob - Queries



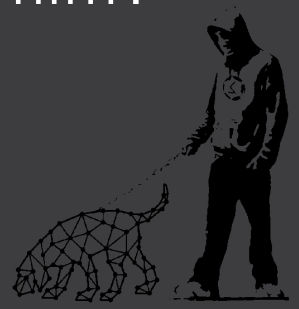
Who Drinks Cappuccino?
[Edge]



Alice & Bob - Queries



Does anyone with red eyes know somebody that drinks cappuccino with coconut milk and that has more cats than him?



Sample DB - Install

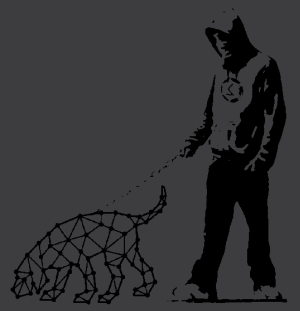
For this workshop, we will use fake AD data

Install as follows:

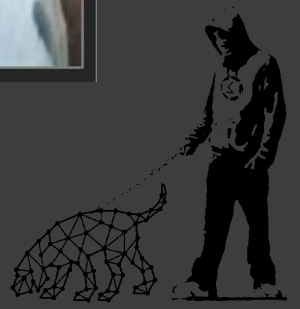
- Download & Unzip folder

https://github.com/SadProcessor/HandsOnBloodHound/blob/master/SampleData/graph.db.practice.zip

- Place in neo4j \data\databases folder
- **Stop neo4j service**
- Rename graph.db to graph.db.old
- **Rename graph.db.training to graph.db**
- **Start service** & Restart BloodHound



BloodHound Data



BloodHound Data - Nodes

BloodHound uses **6 Node types** [aka Node Labels]


:Domain


:Group

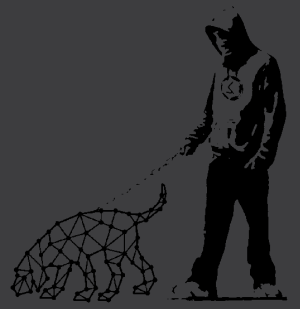

:OU


:Computer


:GPO

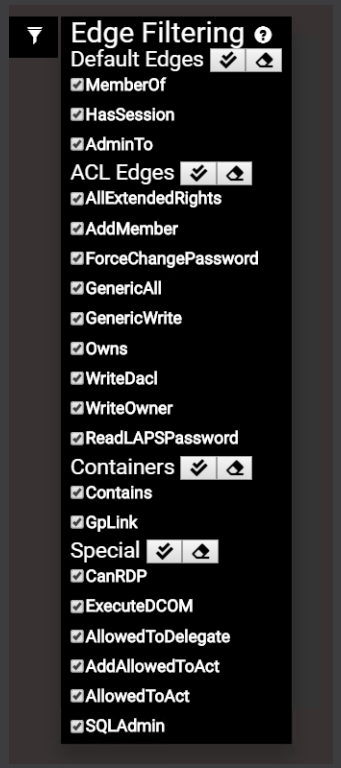

:User

Each Node type has matching set of **properties**



BloodHound Data - Edges

BloodHound uses **19 Edge types**

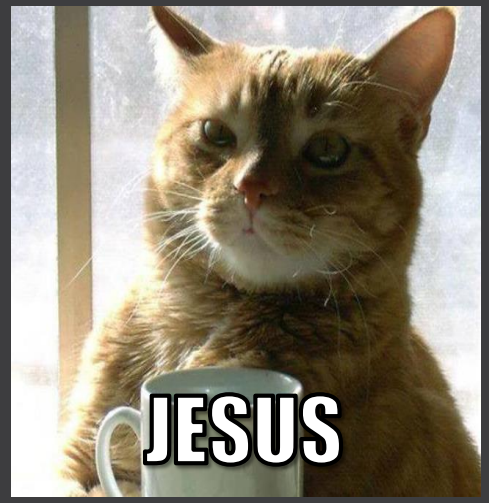


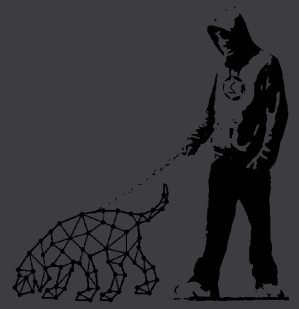
Default
MemberOf
HasSession
AdminTo

Special
ExecuteDCOM
AllowedToDelegate
AddAllowedToAct
AllowedToAct
SQLAdmin

ACL
AllExtendedRights
AddMember
ForceChangePassword
GenericAll
GenericWrite
Owns
WriteDacl
WriteOwner
ReadLAPSPassword

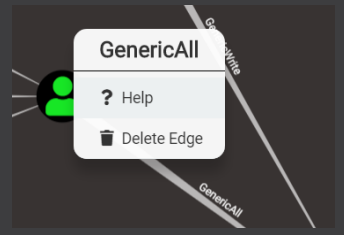
Container
Contains
GpLink



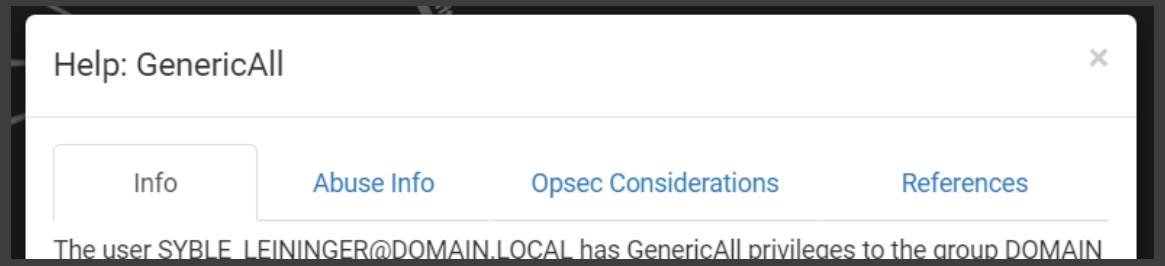


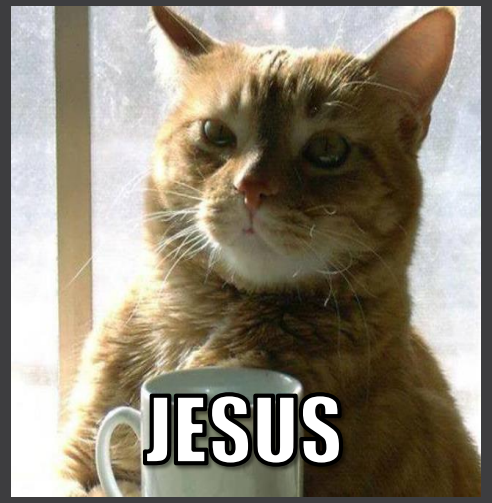
BloodHound Data - Edges

Each Edge represents a [one]way to move

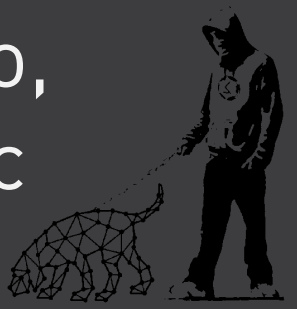


Right-Click Edge for Edge Help





This will open a contextual menu with General Info, Attack Info, Opsec Info, and Extra Refs on the topic



Hands-On: UI Tour

In the **BloodHound UI**, find how to:

- Check BD Properties
- Toggle Dark Mode On/Off [Keep your fav]
- Set Debug Mode On [forever]
- View a Node and it's properties
- View a Path One-to-One
- Request shortest Paths Any-to-One
- Run Build-In Queries

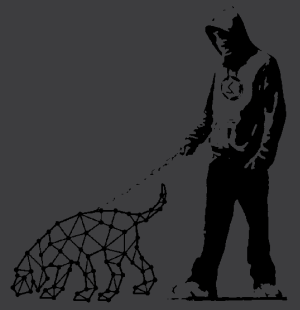
[And more by [right-]clicking around…]

SharpHounds - Info

SharpHound is the BloodHound Data Collector

- [Re]Written in **C#** for better performances
- Uses **LDAP & win32 API Calls** to gather info
- Most data can be collected at user level
- Comes in two flavors [.exe/.ps1]
- Various **Collection Methods** [switches]

Read: https://github.com/BloodHoundAD/BloodHound/wiki/Data-Collector



Collection Methods - Overview

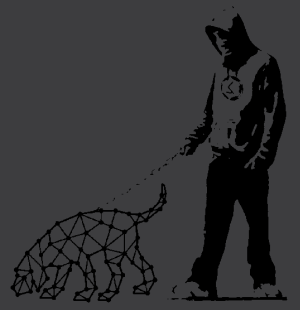
Data collected depends on Collection Method chosen

- To collect everything [no admin needed]

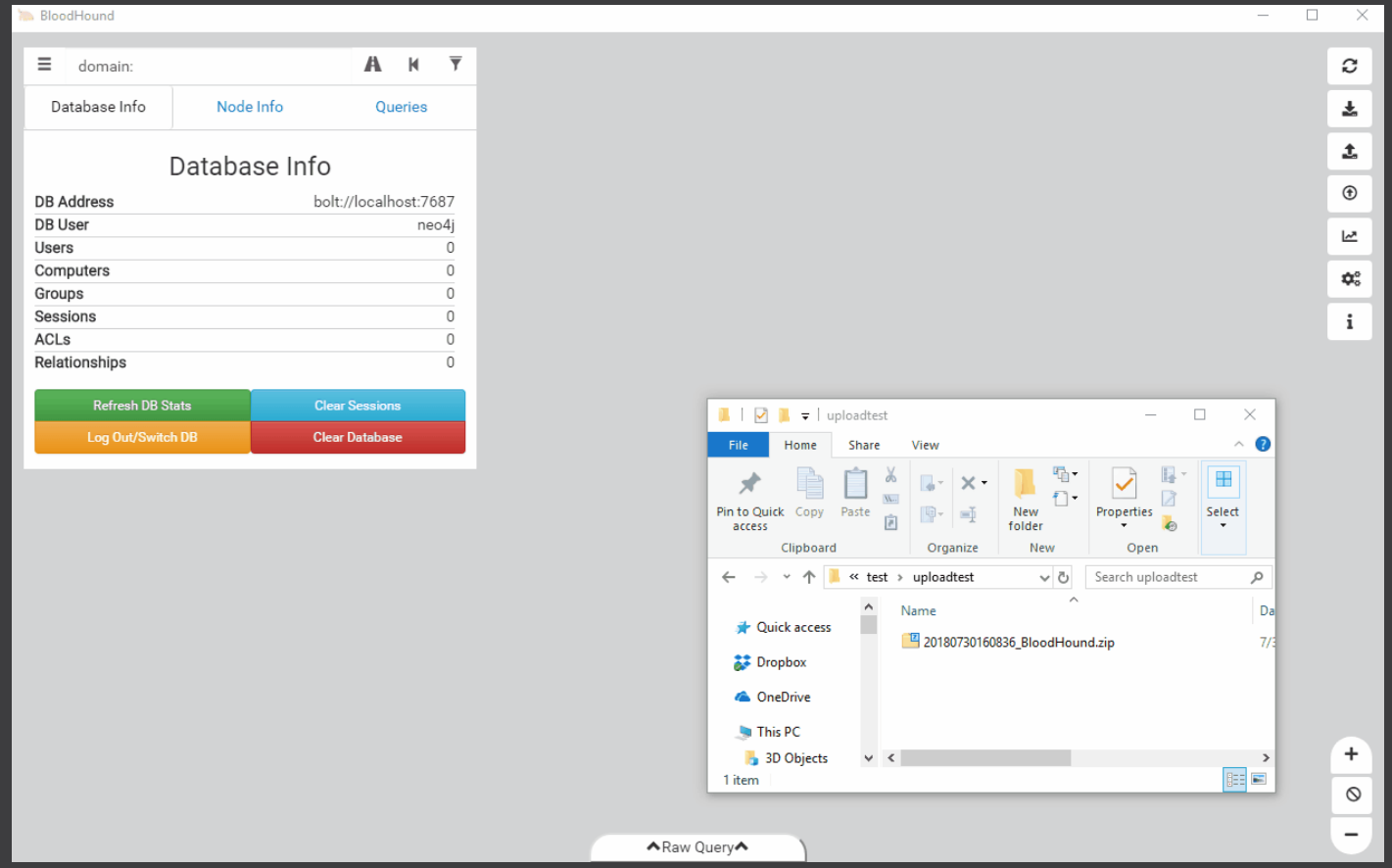
Invoke-BloodHound –CollectionMethod **All** -SearchForest

- Make sure to read Wiki & CptJesus's post on the topic
- Check .ps1 code & Help pages

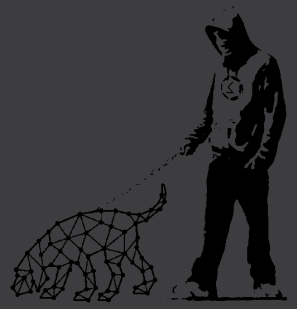
Read: https://github.com/BloodHoundAD/BloodHound/wiki/Data-Collector



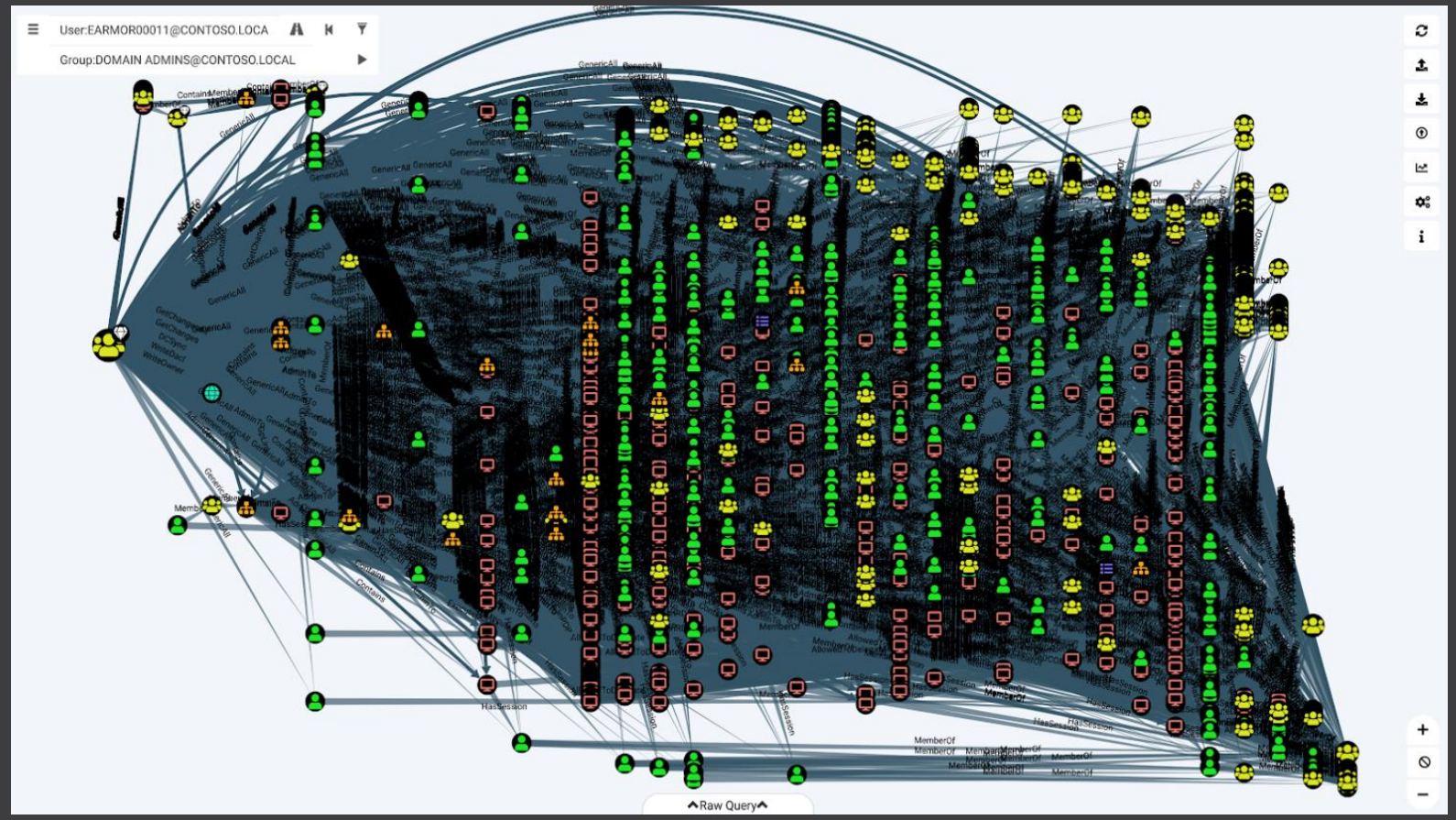
Data Import - HowTo



To Import [more] collected data, simply **drag** [extra] **zip files into the UI**



Data - A lot of data...



How to navigate all this?? LEARN CYPHER...

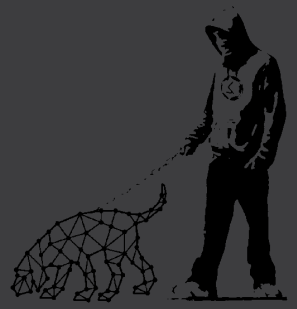
3- Cypher Basics

- Node & Path Queries
- Filtering & Comparing
- Adding & Deleting Stuff
- Debugging Queries
- Neo4j Browser
- Counting Nodes

Node Queries - Basic

Example of basic Node Queries

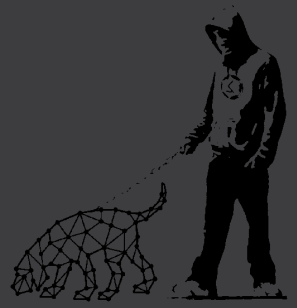
```
// All Nodes
MATCH (x) RETURN x

// All User Nodes
MATCH (x:User) RETURN x

// Node by Property
MATCH (x:User {name: 'BOB@DEMO.LAB'}) RETURN x
```



Path Queries - Basic

Example of Basic Path Query

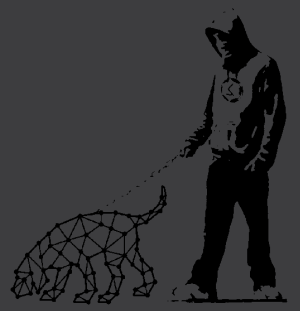
```
// Path User Bob to DA
MATCH (u:User {name:'BOB@DEMO.LAB'})
MATCH (c:Group {name:'DOMAIN ADMINS@DEMO.LAB'})
MATCH p=shortestPath((u)-[r*1..]->(c))
RETURN p
```



Path Queries - Basic

Example Path – Owned to HighValue

```
// Path Own to High Value – All Shortest
MATCH (u:User {highvalue:true})
MATCH (c:Computer {owned:true})
MATCH p=allShortestPaths((c)-[r*1..]->(u))
RETURN p
```

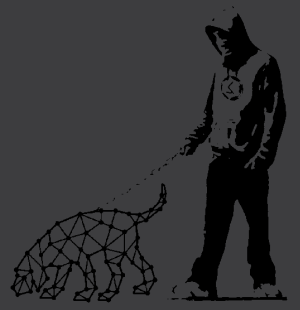


Filtering Stuff - WHERE

The WHERE clause can be used to filter:

```
MATCH (x:User {name: 'BOB@DEMO.LAB'}) RETURN x
// same as
MATCH (x:User)
WHERE x.name='BOB@DEMO.LAB'
RETURN x
```

[WHERE can be used with other operators than equal]

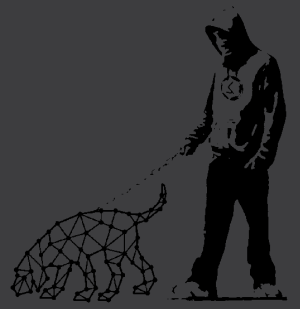


Comparing Stuff - Operators

List of Comparaison Operators:

OPERATOR	SYNTAX
Is Equal To	=
Is Not Equal To	<>
Is Less Than	<
Is Greater Than	>
Is Less or Equal	<=
Is Greater or Equal	>=
Is Null	IS NULL
Is Not Null	IS NOT NULL
Prefix Search*	STARTS WITH
Suffix Search*	ENDS WITH
Inclusion Search*	CONTAINS
RegEx*	=~

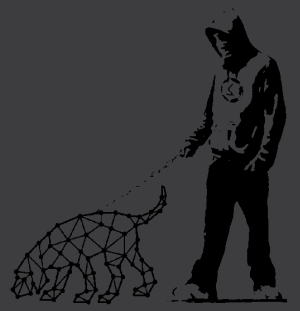
* String specific



Comparing Stuff - Operators

Example using RegEx

```
// Group SID with regex
MATCH (g:Group) WHERE g.objectsid =~ '^S-1-5-32-548$'
RETURN g
```



Hands-On: Nodes&Paths

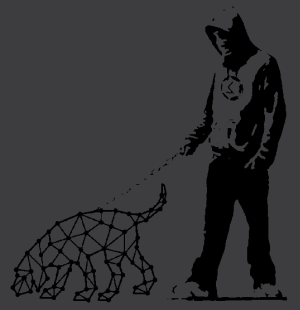
In the **BloodHound UI**:

- Search for User TRUDY_NEELD@DOMAIN.LOCAL
- Check Node properties
- Ask for shortest path from Trudy to Group DOMAIN_ADMINS@DOMAIN.LOCAL
- Ask for same path but without ACL Edges

Adding Stuff - Node

The following syntax is used to create a Node & Add props

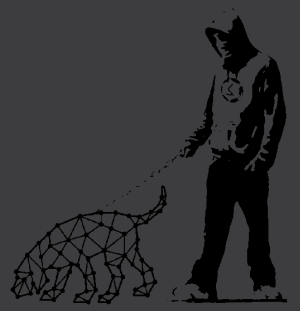
```
// Create Node
MERGE (u:User {name: 'BOB'})

// Add Props
MATCH (u:User {name: 'BOB'})
SET u.age=23, u.hair='Black'
```



Adding Stuff - Edge

The following syntax is used to create an Edge:

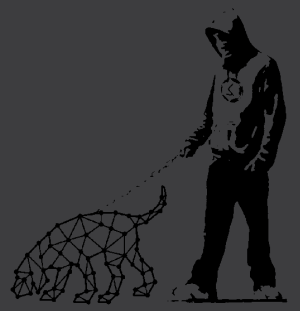
```
// Create Edge Between Nodes
MATCH (b:Human {name: 'BOB'})
MATCH (a:Human {name: 'ALICE'})
CREATE (b)-[r:Likes]->(a)
```



Deleting Stuff - Edge

The following syntax is used to delete an Edge:

```
// Delete Relationship
MATCH (b:Human {name: 'BOB'})-[r:Likes]->(a:Human {name: 'ALICE'})
DELETE r
```

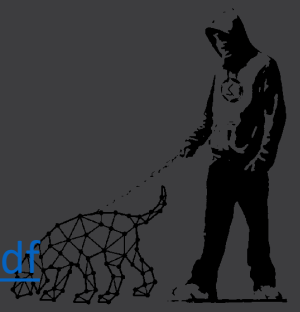


Deleting Stuff - Node

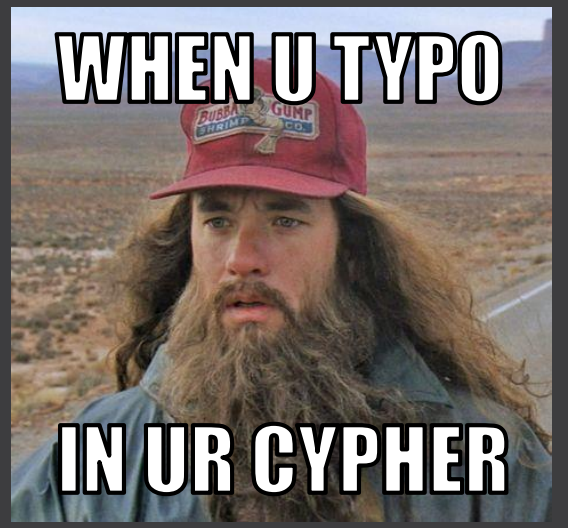
The following syntax is used to delete a Node:

```
// Delete Node
MATCH (u:User {name: 'BOB'})
DETACH DELETE u
```

More: https://www.ernw.de/download/BloodHoundWorkshop/ERNW_DogWhispererHandbook.pdf



Making Errors - Typos



It happens...

- UI will not show any error message
- Your dog will run forever
- Prefer Browser to Build/Debug queries

ERROR

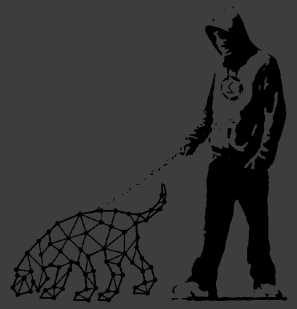
Neo.ClientError.Statement.SyntaxError

```
Neo.ClientError.Statement.SyntaxError: Invalid input ';': expected an identifier character, node la
pattern (line 1, column 9 (offset: 8))
"MATCH (u;User) RETURN u"
         ^
```

Hands-On: GodMode

Perform the following:

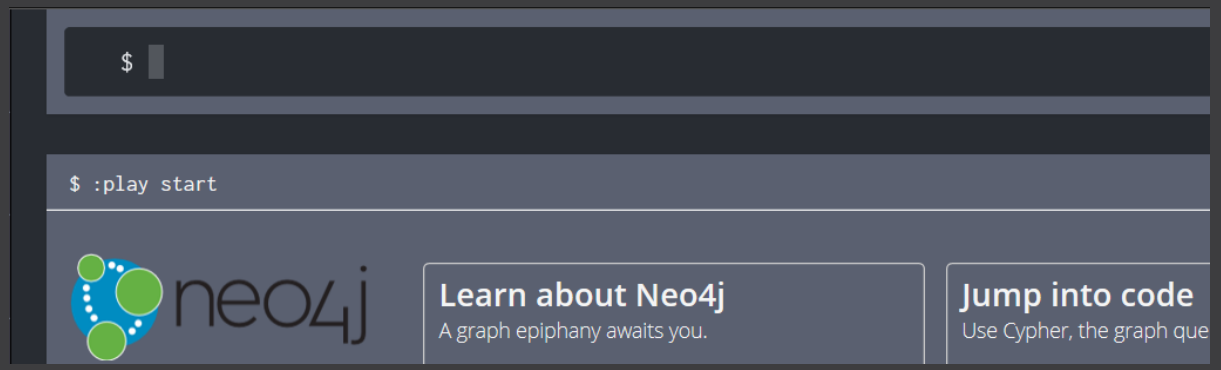
- **Create Humans** named Alice & Bob
- **Add an age property** to each
- **Create relationships** between them
- **Request path** from Alice to Bob
- **Delete an Edge**
- **Delete Both Nodes**



Neo4j Browser - 2nd Home

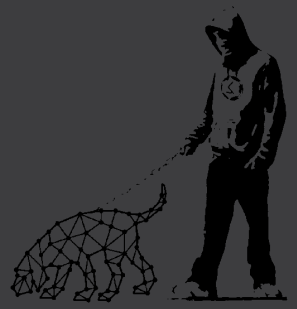
The Neo4j Browser is the best place to work on queries:

- Bigger font
- Syntax coloring
- Error messages
- **Return numbers**



And more...

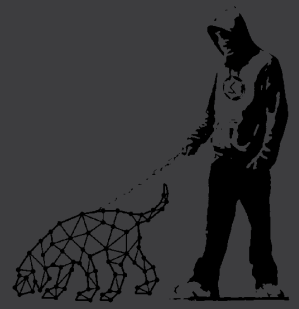
It is located at http://localhost:7474



Counting Stuff - COUNT()

The following syntax can be used to count Nodes

```
MATCH
(g:Group {name: 'DOMAIN ADMINS@SUB.DOMAIN.LOCAL'}),
p=shortestPath((x:User)-[r*1..]->(g))
RETURN COUNT(DISTINCT(x))
```



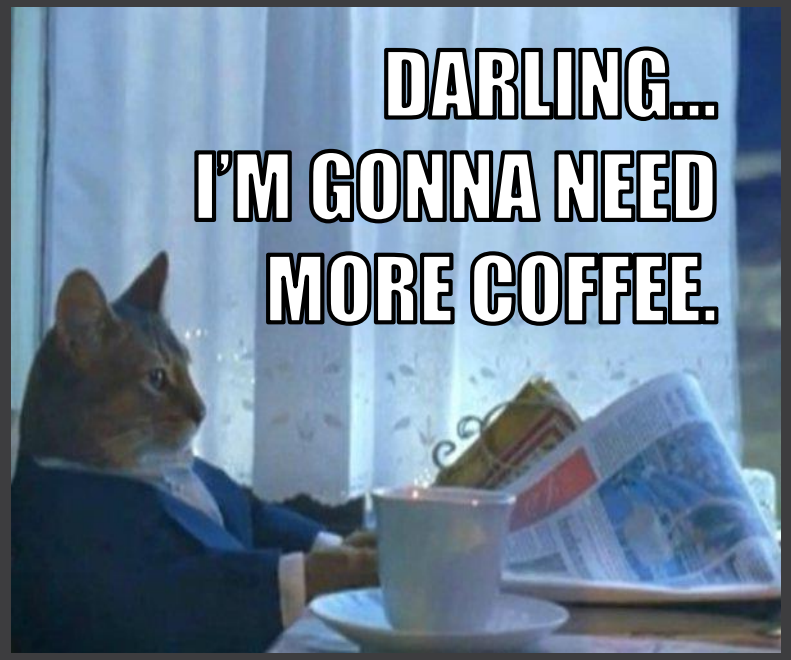
Hands-On: Browser

Using the **neo4j browser**:

- Try **Nodes&Paths** exercise again
- Try **GodMode** exercise again
- Try **counting** some Nodes

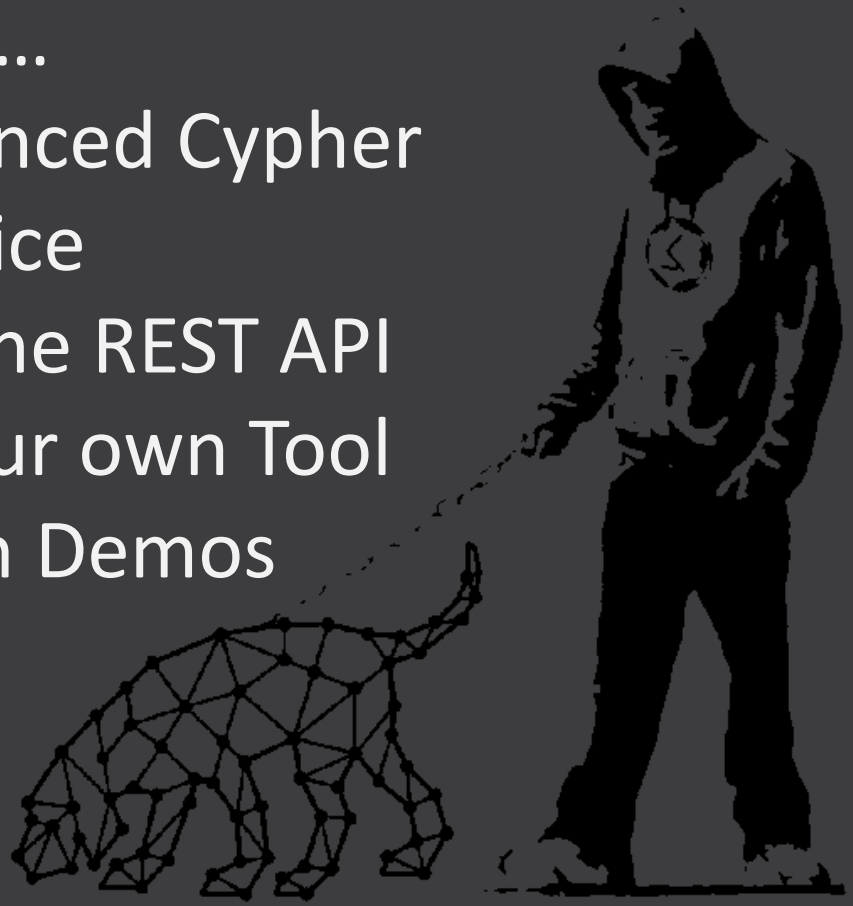
[Make Errors…]

Break [10m]



And after that...

- Some Advanced Cypher
- More Practice
- A bit over the REST API
- Building your own Tool
- Automation Demos

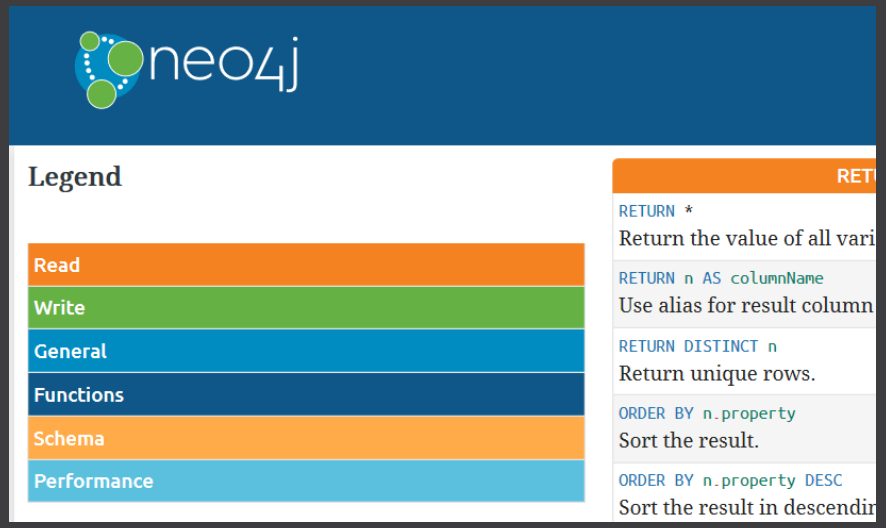


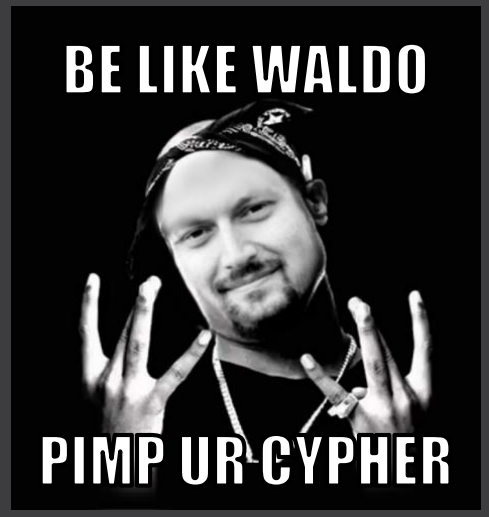
4- Cypher Advanced

- More Functions()
- Cypher Manual
- Cypher Gallery
- Query Tuning

More Functions() - Ref Card

There are many Functions available...
Check out the **cypher Reference Card** for a quick overview...



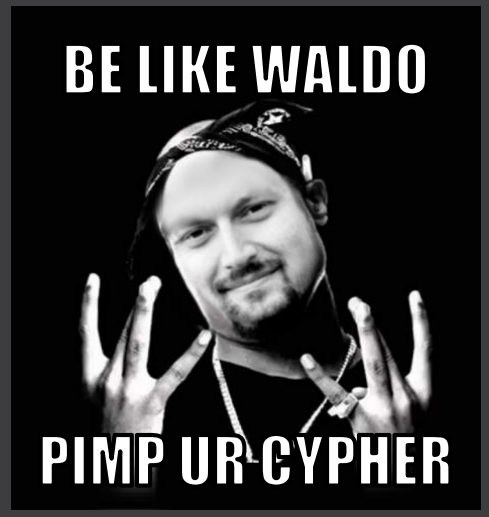


Ref: https://neo4j.com/docs/cypher-manual/3.5/

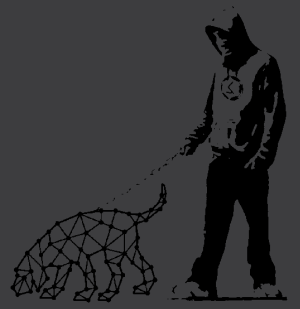
More Functions() - Example

See if you can understand what happens in this bit of cypher [use the ref card]

```
...
 WHERE ALL(x in RELS(p) WHERE (TYPE(x)='MemberOf' OR x.isacl=true))
...
```

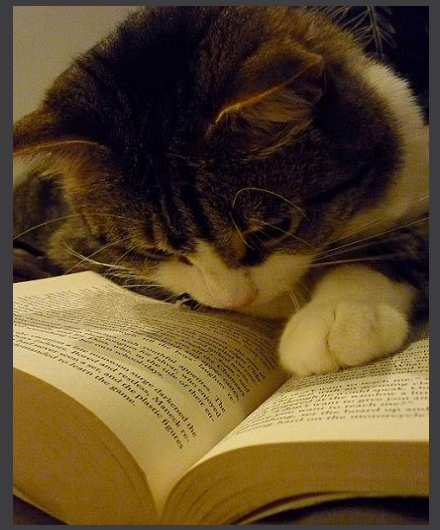


Ref: https://neo4j.com/docs/cypher-manual/3.5/



Cypher Manual - The Bible

We have only scratched the surface...
There is a full Cypher online reference waiting for you



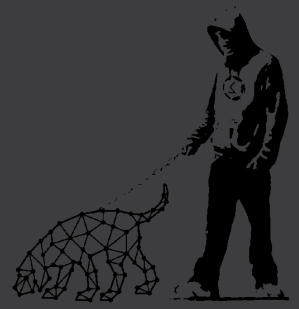
The Neo4j Cypher Manual v3.5

This is the Cypher manual for Neo4j version 3.5, authored by the Neo4j Team.

This manual covers the following areas:

- Chapter 1, *Introduction* — Introducing the Cypher query language.
- Chapter 2, *Syntax* — Learn Cypher query syntax.
- Chapter 3, *Clauses* — Reference of Cypher query clauses.
- Chapter 4, *Functions* — Reference of Cypher query functions.
- Chapter 5, *Schema* — Working with indexes and constraints in Cypher.
- Chapter 6, *Query tuning* — Learn to analyze queries and tune them for performance.
- Chapter 7, *Execution plans* — Cypher execution plans and operators.
- Chapter 8, *Deprecations, additions and compatibility* — An overview of language developments across

Manual: https://neo4j.com/docs/cypher-manual/3.5/



Cypher Gallery - Community

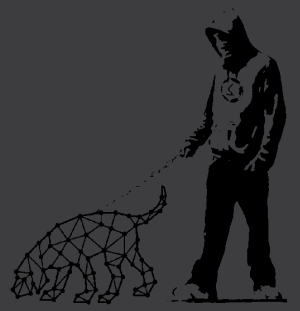
List of Cypher cheats by Community Members

https://gist.github.com/jeffmcjunkin/7b4a67bb7dd0cfbfbd83768f3aa6eb12

https://hausec.com/2019/09/09/bloodhound-cypher-cheatsheet/

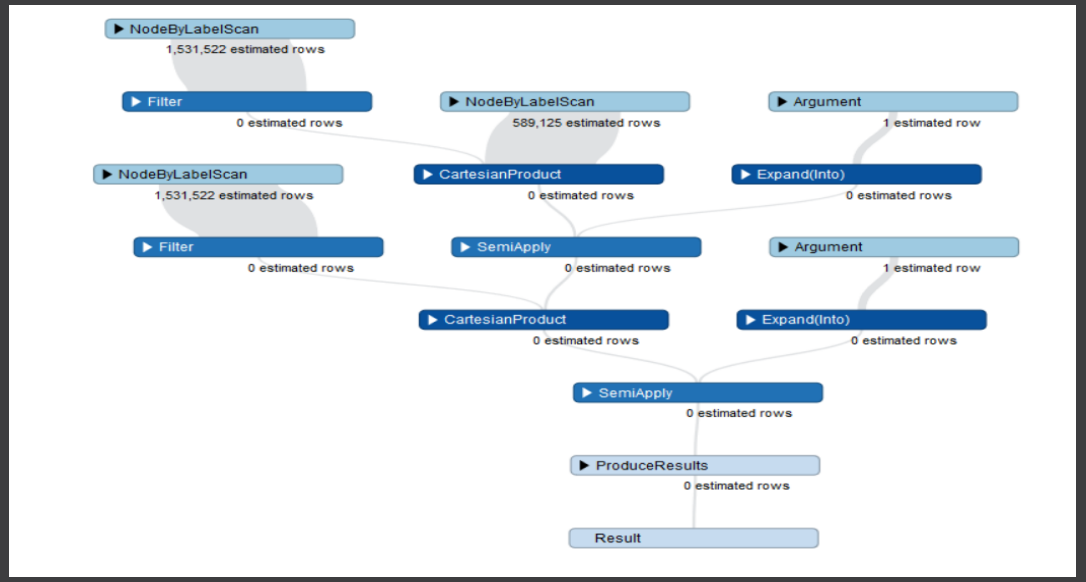
https://github.com/BloodHoundAD/BloodHound/wiki/Cypher-Query-Gallery

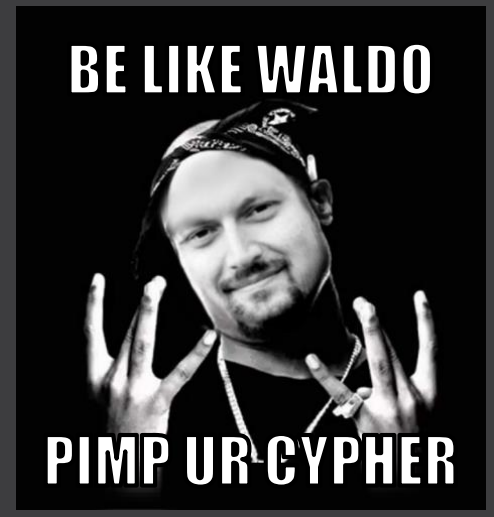
Share your cool queries on BloodHound slack...

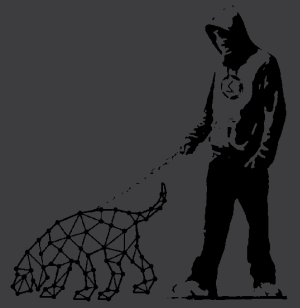


Query Tuning - Performance

Tip: Add **EXPLAIN** or **PROFILE** in front of your Cypher Query to understand how it performs under the hood... [Browser Only]







Hands-On: Moar Cypher

Check out the **Cypher Gallery** links and:

- Find some cool **Queries** you like
- **Tweak** them to your pleasure
- Run them in **UI** & **Browser**
- Add **EXPLAIN** & **PROFILE** in front

[Make moar errors…]

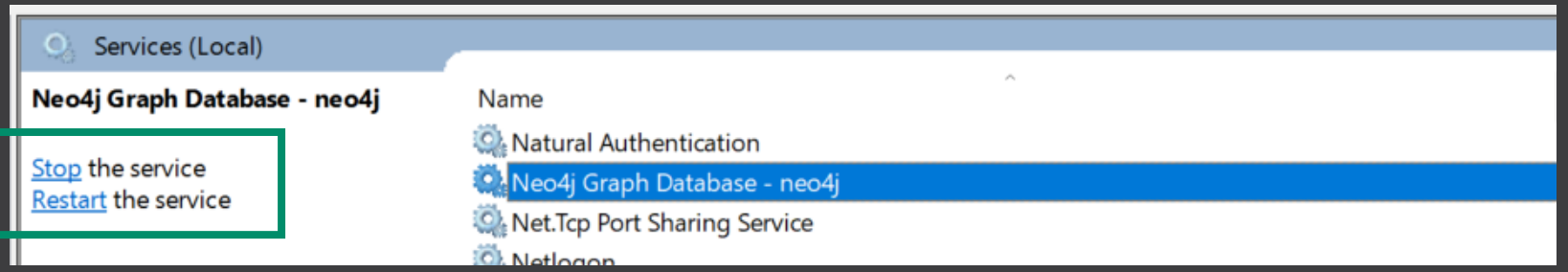
5- REST API & Automation

- REST API Basics
- Invoke-Cypher
- CypherDog Demo [Full Client]
- WatchDog Demo [Metrics & Report]

REST API - Setup

Enable **Unauthenticated** API requests [/!\ LocalHost Only /!\]

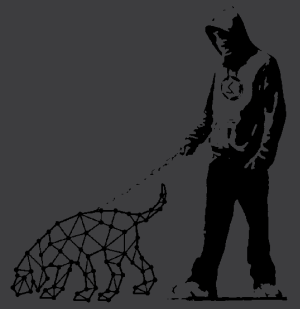
- Stop neo4j service



- Uncomment in neo4j\conf\neo4j.conf

```
24  # Whether requests to Neo4j are authenticated.
25  # To disable authentication, uncomment this line
26  dbms.security.auth_enabled=false
```

- Start neo4j service

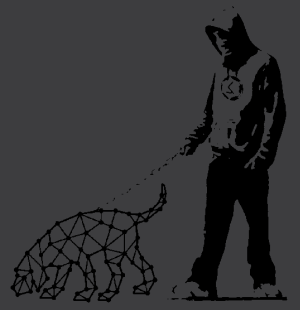


REST API - Basic Call

```powershell
# Prep Vars
$Server = 'localhost'
$Port   = '7474'
$Uri    = "http://$Server:$Port/db/data/cypher"
$Header = @{'Accept'='application/json; charset=UTF-8';'Content-Type'='application/json'}
$Method = 'POST'
$Body   = '----- tbd -----'

# Set body
$Body = '{
    "query" : "MATCH (A:Computer {name: {ParamA}}) RETURN A",
    "params" : { "ParamA" : "APOLLO.EXTERNAL.LOCAL" }
    }'


# Make Call
$Reply = Invoke-RestMethod -Uri $Uri -Method $Method -Headers $Header -Body $Body

```

PowerShell example of a basic call to API

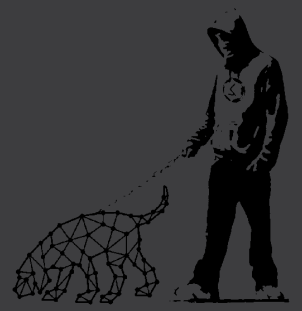
Bash: https://github.com/BloodHoundAD/BloodHound/wiki/neo4j-REST-API



REST API - Nodes

This is what a returned Node looks like [PoSh]

```
> cypher "MATCH (n:User {name: 'JACOB_NEWELL@SUB.DOMAIN.LOCAL'}) RETURN n" -Expand data


metadata                    : @{id=410; labels=System.Object[]}
data                        : @{highvalue=False; sensitive=True; enabled=True; hasspn=False
                              domain=SUB.DOMAIN.LOCAL; name=JACOB_NEWELL@SUB.DOMAIN.LOCAL;
                              objectsid=S-1-5-21-2505991005-2303352498-2358670217-2111; adm
paged_traverse              : http://localhost:7474/db/data/node/410/paged/traverse/{returr
outgoing_relationships      : http://localhost:7474/db/data/node/410/relationships/out
outgoing_typed_relationships : http://localhost:7474/db/data/node/410/relationships/out/{-li
labels                      : http://localhost:7474/db/data/node/410/labels
create_relationship         : http://localhost:7474/db/data/node/410/relationships
traverse                    : http://localhost:7474/db/data/node/410/traverse/{returnType}
extensions                  :
all_relationships           : http://localhost:7474/db/data/node/410/relationships/all
all_typed_relationships     : http://localhost:7474/db/data/node/410/relationships/all/{-li
property                    : http://localhost:7474/db/data/node/410/properties/{key}
self                        : http://localhost:7474/db/data/node/410
incoming_relationships      : http://localhost:7474/db/data/node/410/relationships/in
properties                  : http://localhost:7474/db/data/node/410/properties
incoming_typed_relationships : http://localhost:7474/db/data/node/410/relationships/in/{-lis
```

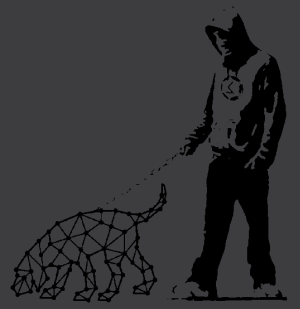


REST API - Paths

This is what a returned Path looks like [PoSh]

```
relationships : {http://localhost:7474/db/data/relationship/50808, http://localhost:7474/db/data/relationship/46395,
                http://localhost:7474/db/data/relationship/50312, http://localhost:7474/db/data/relationship/50313...}
nodes         : {http://localhost:7474/db/data/node/373, http://localhost:7474/db/data/node/477, http://localhost:7474/db/data/node/48395,
                http://localhost:7474/db/data/node/472...}
directions    : {->, ->, ->, ->...}
length        : 5
start         : http://localhost:7474/db/data/node/373
end           : http://localhost:7474/db/data/node/47074
```

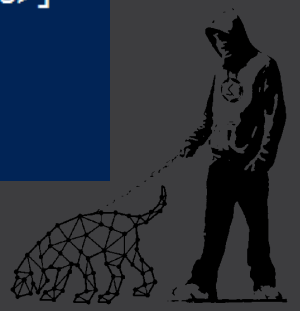
More calls will need to be made to retrieve Node & Edge info [curl/irm]



Invoke-Cypher - Cmdlet

Invoke-Cypher is a simple Cmdlet to send Cypher queries to the BloodHound REST API.

```
> help Invoke-Cypher

NAME
    Invoke-Cypher

SYNOPSIS
    Invoke Cypher


SYNTAX
    Invoke-Cypher [-Query] <String> [[-Params] <Hashtable>] [[-Expand] <String[]>] [<CommonParameters>]


DESCRIPTION
    Post Cypher Query to BloodHound REST API
```



Hands-On: API Calls

Read the **Invoke-Cypher**.ps1 Cmdlet code and help page. Using the Cmdlet:

- Try **Nodes&Paths e**xercise again
- Try **GodMode** exercise again
- Try other queries of your creation

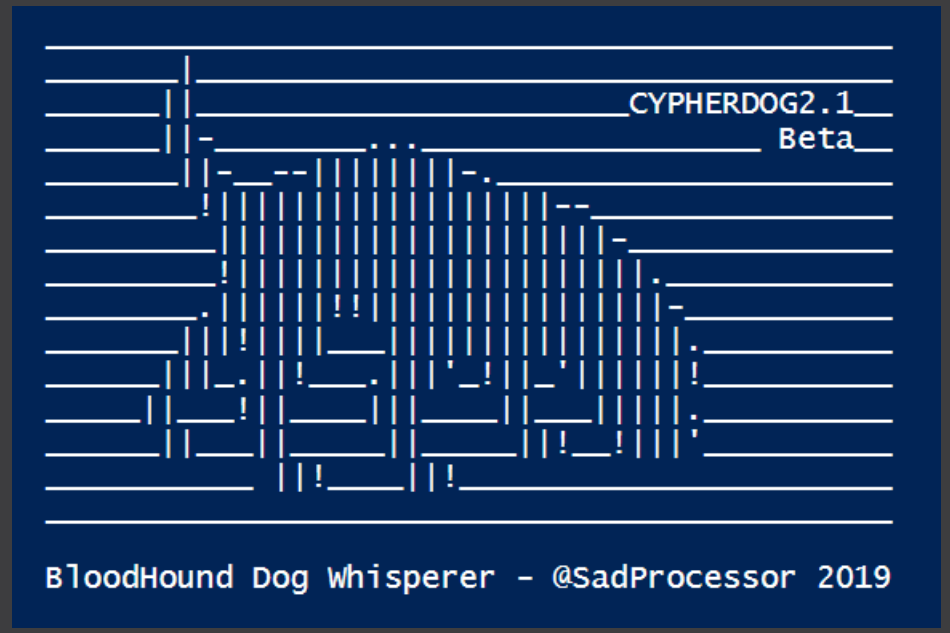
[**Get-Help** Invoke-Cypher -Full]

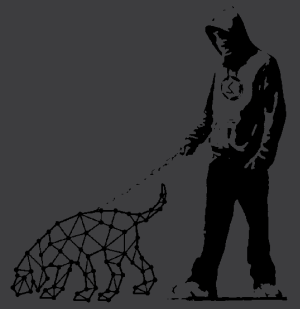
Tool Demos [if enough time]

- CypherDog
- WatchDog

CypherDog - Demo

CypherDog is a PowerShell BloodHound Client allowing Data Manipulation & Automation

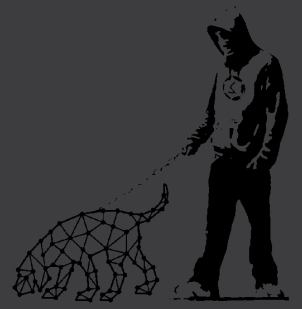




WatchDog - Demo

WatchDog is an BloodHound Data Scanner [POC/WiP]

```
Top20 Overall - TotalImpact [ 19 : 637 : 100 ]
--------------------------

Type     Name                                    Hit Weight Impact
----     ----                                    --- ------ ------
Group    ENTERPRISE ADMINS@DOMAIN.LOCAL           19    158   24.8
User     SYBLE_LEININGER@DOMAIN.LOCAL             19    143   22.4
Group    ACCOUNT OPERATORS@DOMAIN.LOCAL           18    141   22.1
User     HAZEL_DUNFEE@SUB.DOMAIN.LOCAL            19    104   16.3
Computer WS_4.DOMAIN.LOCAL                        19     95   14.9
Group    REMOTE MANAGEMENT USERS@DOMAIN.LOCAL     19     95   14.9
User     EUGENIE_HITES@DOMAIN.LOCAL               19     86   13.5
Computer WS_17.SUB.DOMAIN.LOCAL                   18     85   13.3
Computer WS_12.SUB.DOMAIN.LOCAL                   19     79   12.4
Group    DOMAIN GUESTS@SUB.DOMAIN.LOCAL           19     79   12.4
Group    DOMAIN ADMINS@DOMAIN.LOCAL               18     77   12.1
Group    DISTRIBUTED COM USERS@SUB.DOMAIN.LOCAL   16     66   10.4
User     SHERWOOD_ENDRES@DOMAIN.LOCAL             19     65   10.2
User     MICHEAL_MAURER@DOMAIN.LOCAL              19     55    8.6
Computer SRV_9.DOMAIN.LOCAL                       19     55    8.6
User     PENNI_ROGAN@DOMAIN.LOCAL                 19     54    8.5
Group    RAS AND IAS SERVERS@SUB.DOMAIN.LOCAL     19     54    8.5
User     SOLEDAD_UHRIG@DOMAIN.LOCAL               19     47    7.4
User     THI_RODKEY@DOMAIN.LOCAL                  19     47    7.4
User     LOREAN_EUGENE@DOMAIN.LOCAL               19     45    7.1
```

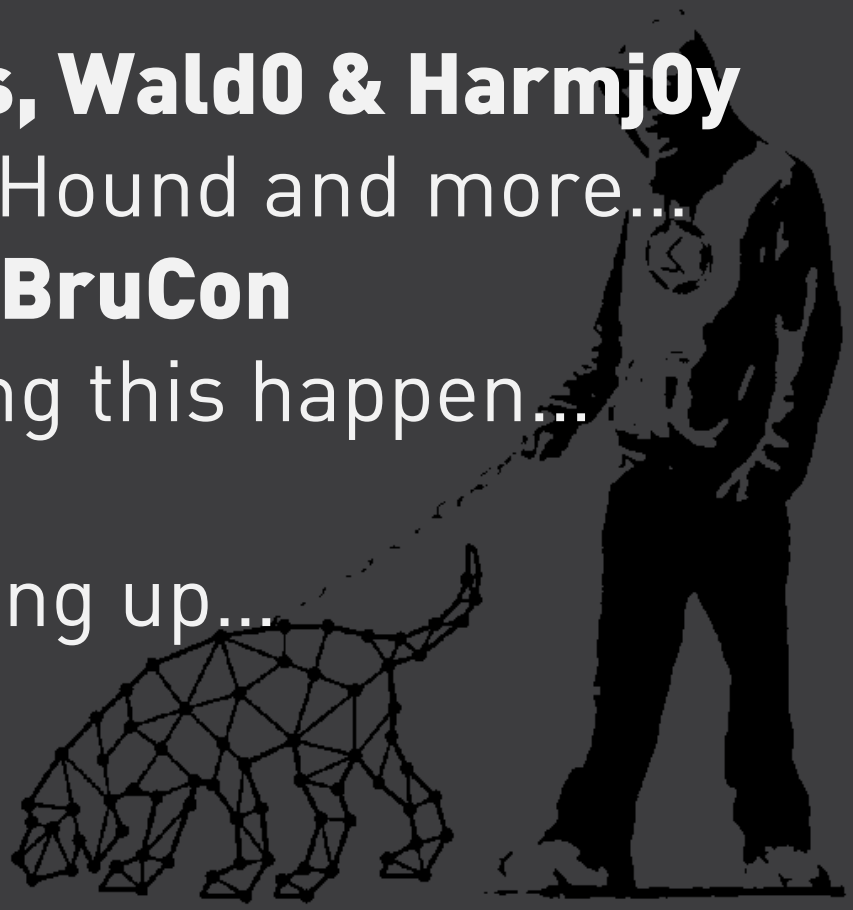


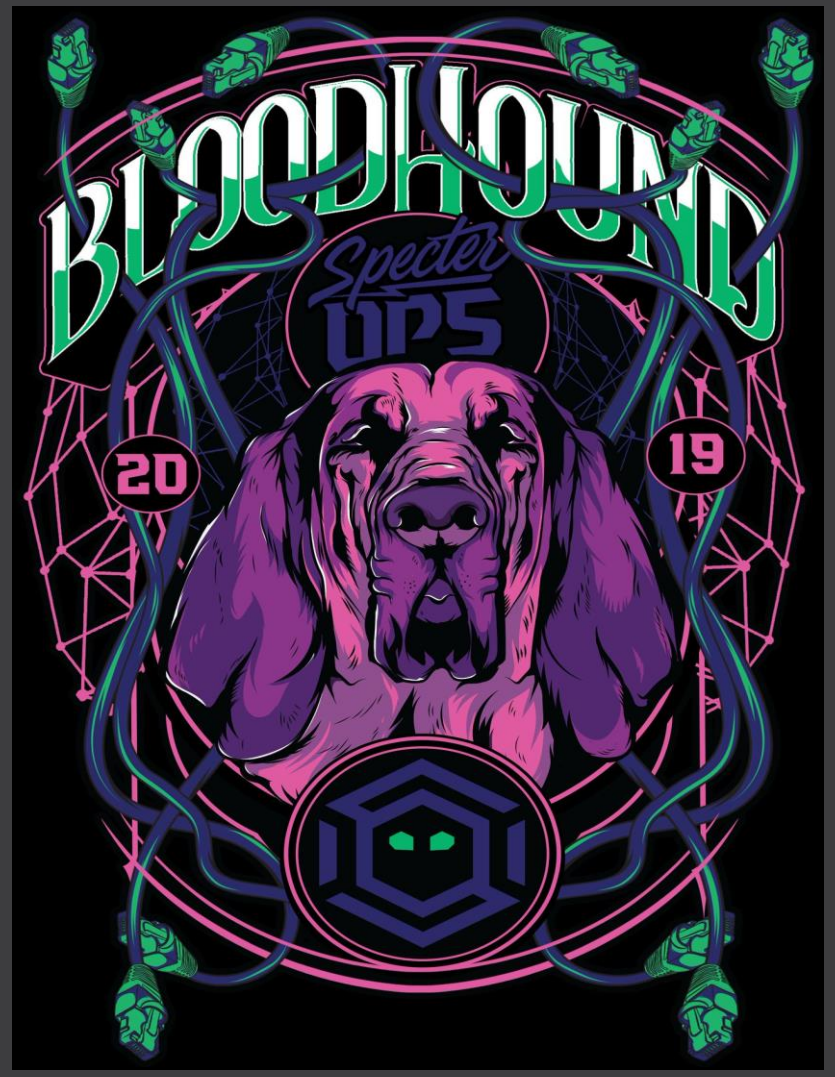
Questions...

If we have time.
If not, see you on the
BloodHound Slack...

Thank You...

- **CptJesus, Wald0 & Harmj0y**
  for BloodHound and more...
- **ERNW & BruCon**
  for making this happen...
- **You**
  for showing up...





Support...

BloodHound is a great tool.
And it's **free**.

If you use it on a regular basis, why not support a **good cause** and treat yourself with some **BloodHound Swag**...

All benefits go to **Charity**