

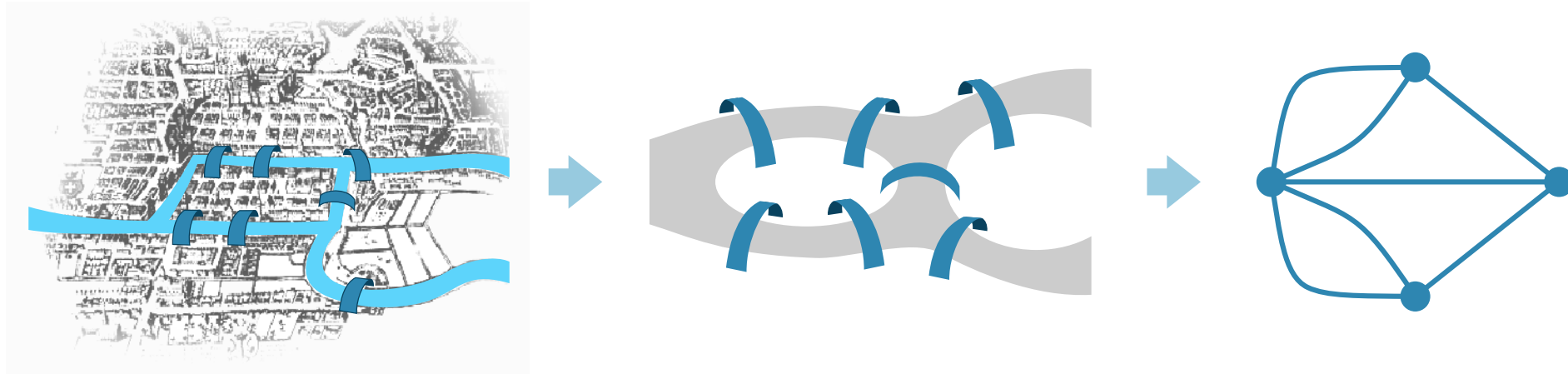
Graph databases

- why and how

About me

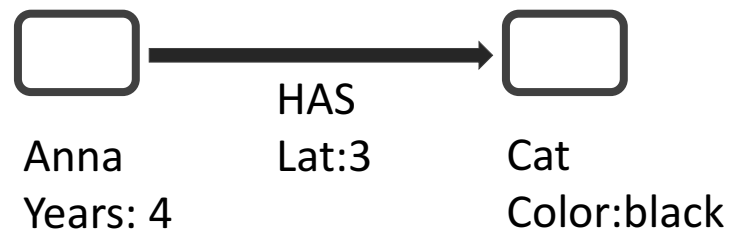
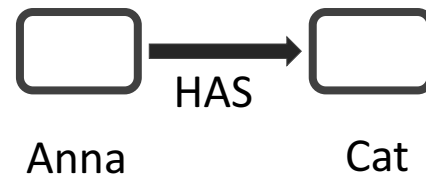
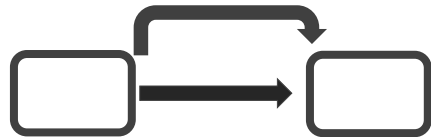
- Chief Software Architect at **ITMAGINATION**
- Architect in one of the biggest .NET project in Poland.
- Interested in distributed systems and digging into data.
- Running a pet project **cook***it*

Graph

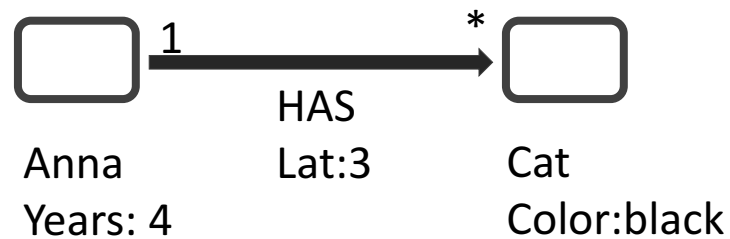
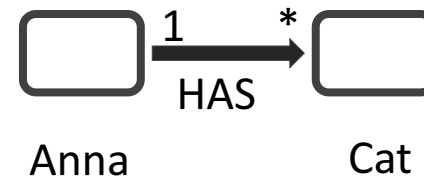
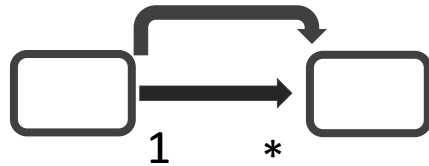
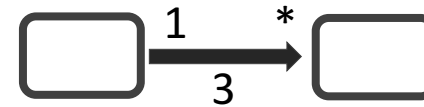
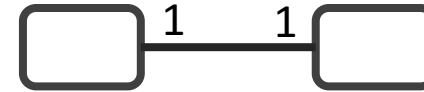


$$G=(E,V)$$

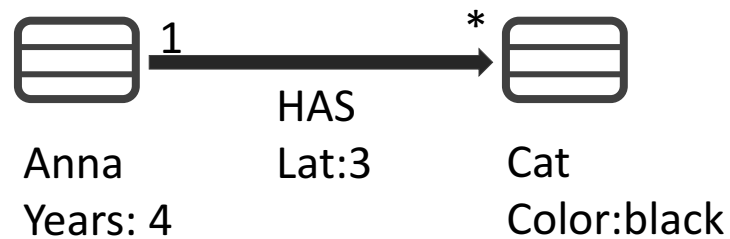
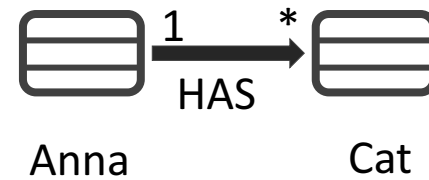
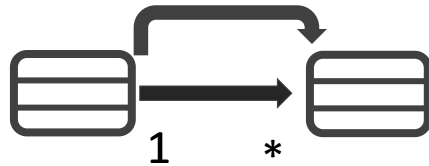
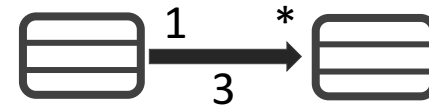
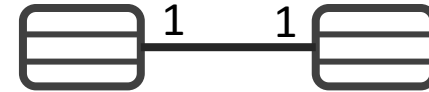
Graph



Graph



Graph



A bit of history

Relational database history

- 1970 – Edgar F. Codd – the relational model
- What else happened in the 70s?
 - RAM got „cheaper” – only 734\$ for 1 MB (24 M
 - IBM 3310 offers 100MB disc
 - 1971 Intel 4004 – 740kHz, 8 bit (1000 kHz = 1 MHz)
 - 1974 Intel 8008 – 800kHz, 16 bit
 - 1977 Oracle, Apple 1
 - 1978 Intel 8086 – 4MHz- 10MHz (1000 MHz = 1 GHz)



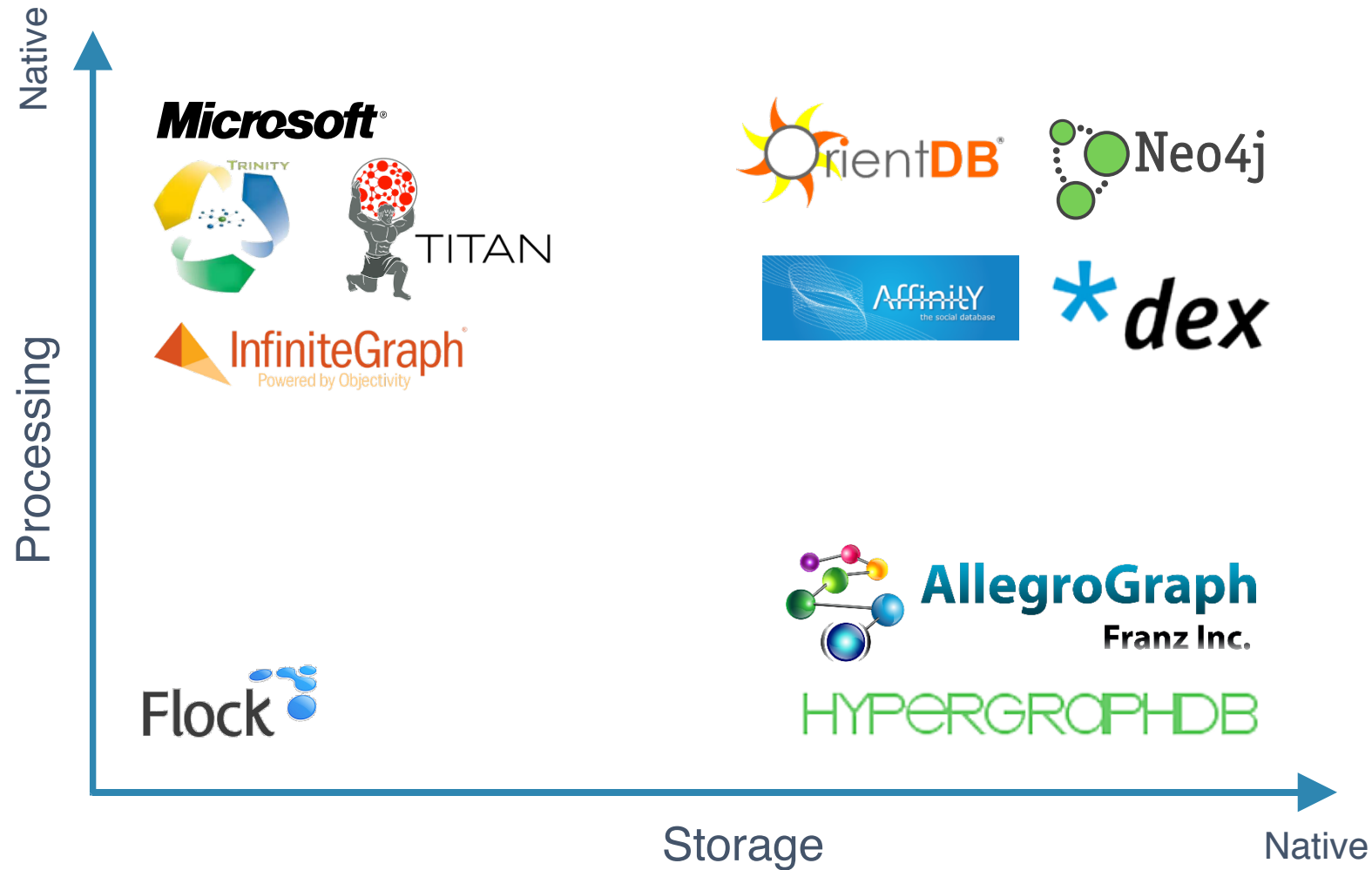
Graph database history

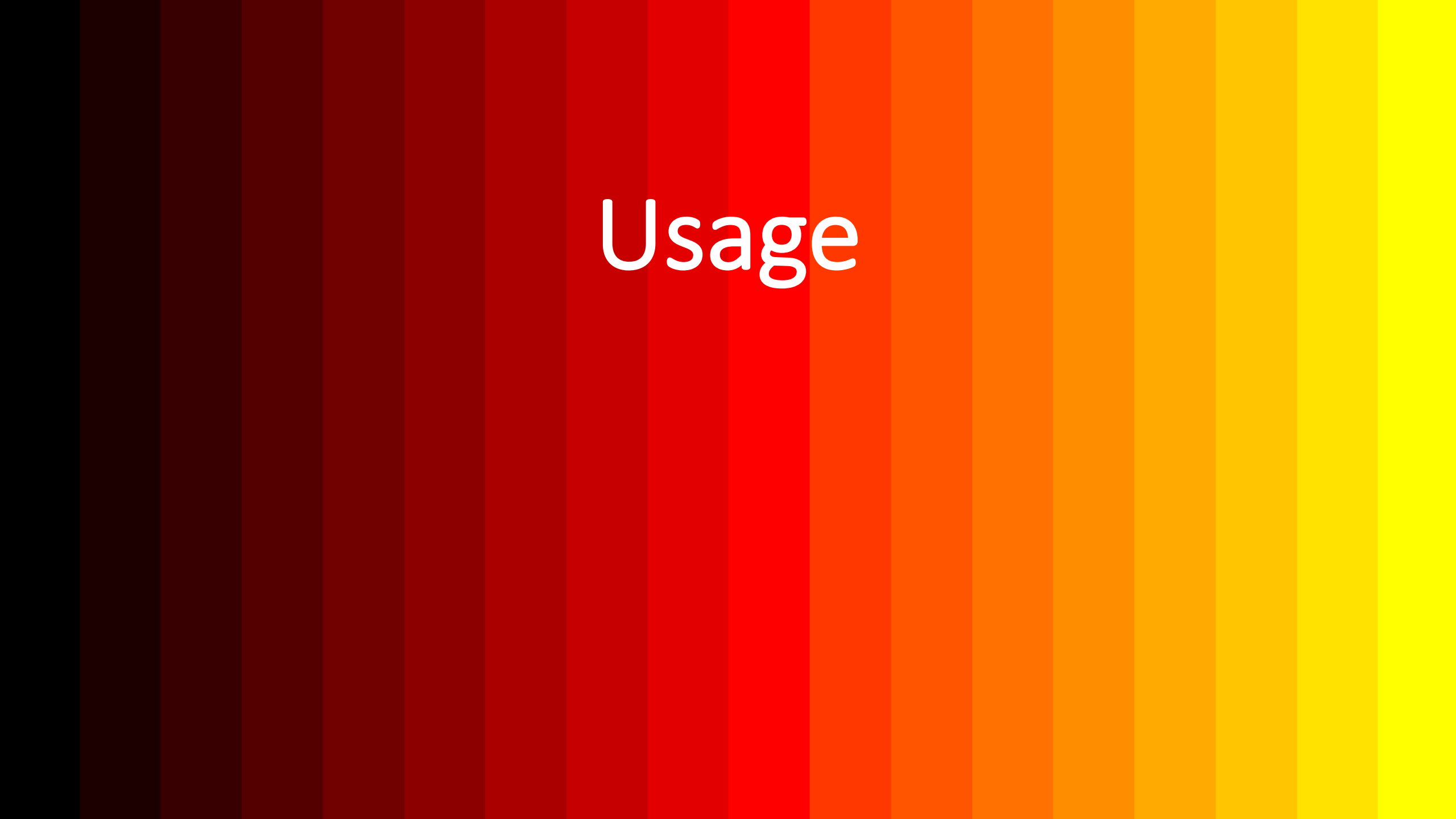
- 1736 – Bridge problem
- 1852 – Map-coloring problem
- 1936 – The book „Graph theory”
- 1969 – The map problem is partly solved
- 1994 – The map problem is solved
- 2002 – Pentium 4 3,8GHz
- 2003 – First commercial graph databases



НИИКС.РУ
WWW.NIX.RU

Current state





Usage

Suggestions

The screenshot shows the Amazon product page for the book "Writing High-Performance .NET Code" by Ben Watson. The page includes the book cover, a "Look inside" link, and pricing for Kindle (\$9.99) and Paperback (\$22.49). It also features a "Frequently Bought Together" section with three books: "Writing High-Performance .NET Code", "Adaptive Code via C#", and "Microsoft .NET - Architecting Applications for the Enterprise (2nd Edition)". Below this is a "Customers Who Bought This Item Also Bought" section with six more books: "Microsoft .NET - Architecting Applications for the Enterprise (2nd Edition)", "Adaptive Code via C#", "Concurrency in C# Cookbook", "C# in Depth, 3rd Edition", "Pro C# 5.0 and the .NET 4.5 Framework", "C# Design Pattern Essentials", and "ASP.NET Web API 2: Building a REST...".

Writing High-Performance .NET Code Paperback – July 23, 2014
by Ben Watson (Author)
★★★★★ 33 customer reviews

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Do you want your .NET code to have the absolute best performance it can? This book demystifies the CLR, teaching you how and why to write code with optimum performance. Learn critical lessons from a person who helped design and build one of the largest high-performance .NET systems in the world. This book does not just teach you how the CLR works—it teaches you exactly what you need to do now to obtain the best performance today. It will expertly guide you through the nuts and bolts of extreme performance optimization in .NET, complete with in-depth examinations of CLR functionality.

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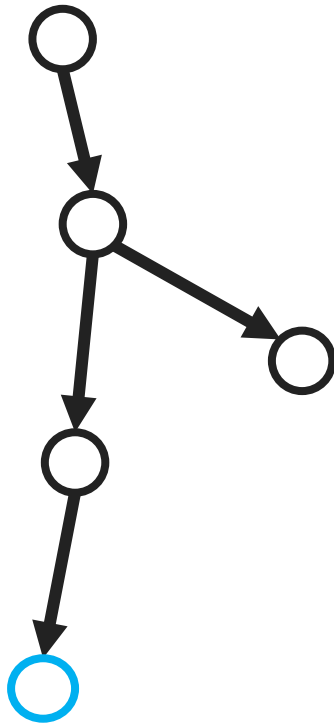
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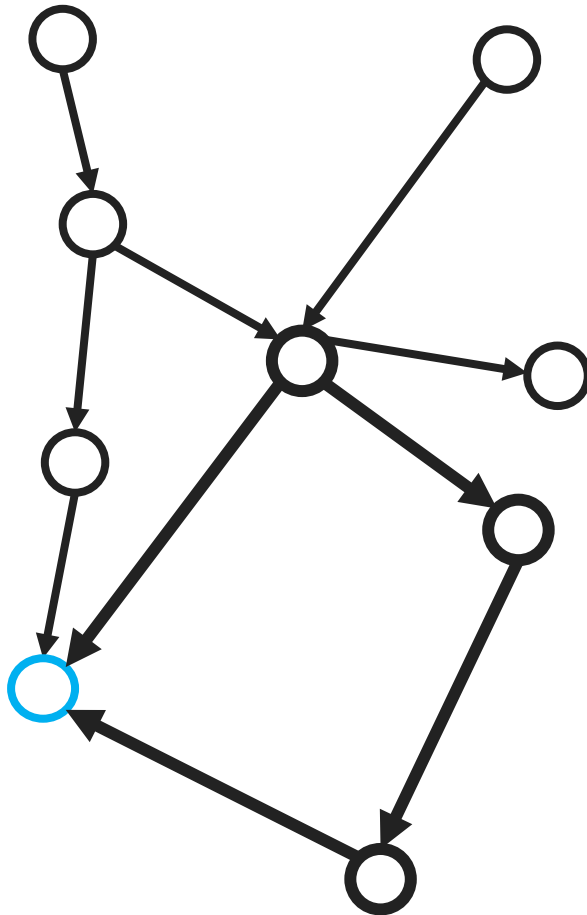
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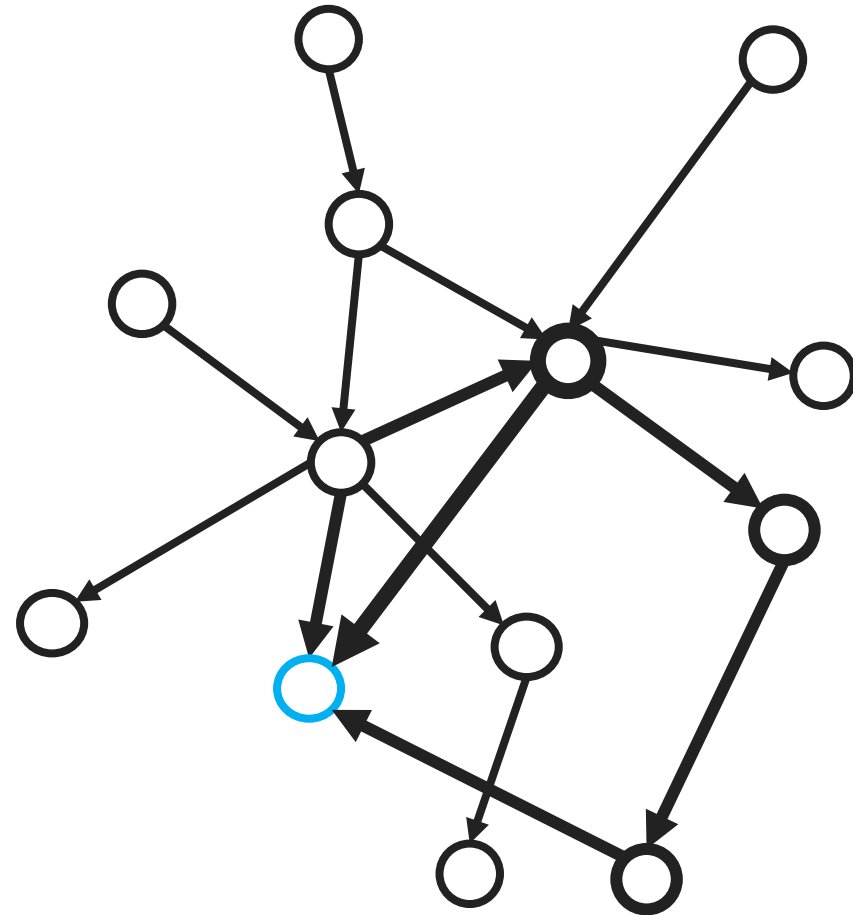
Suggestions



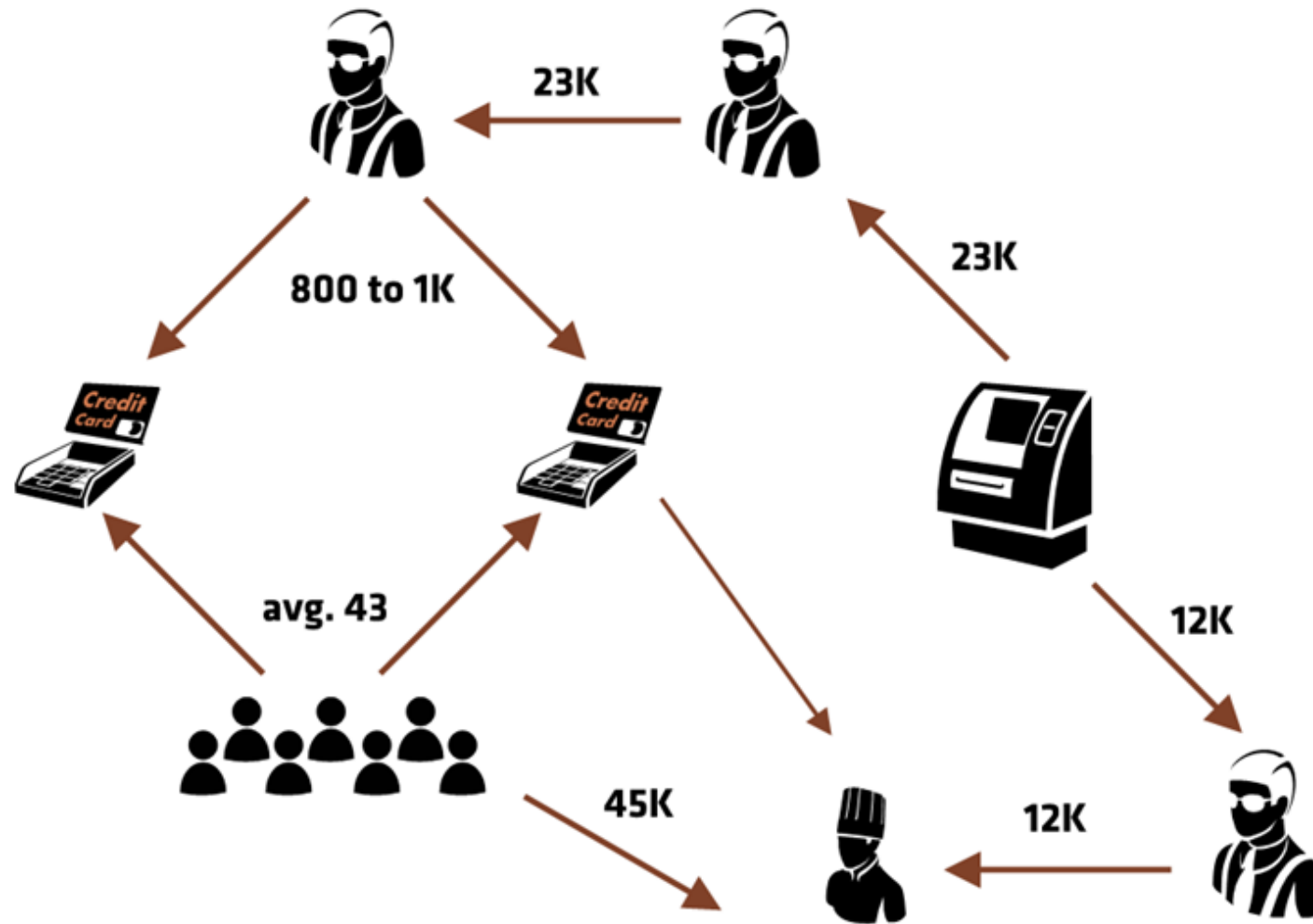
Suggestions



Suggestions



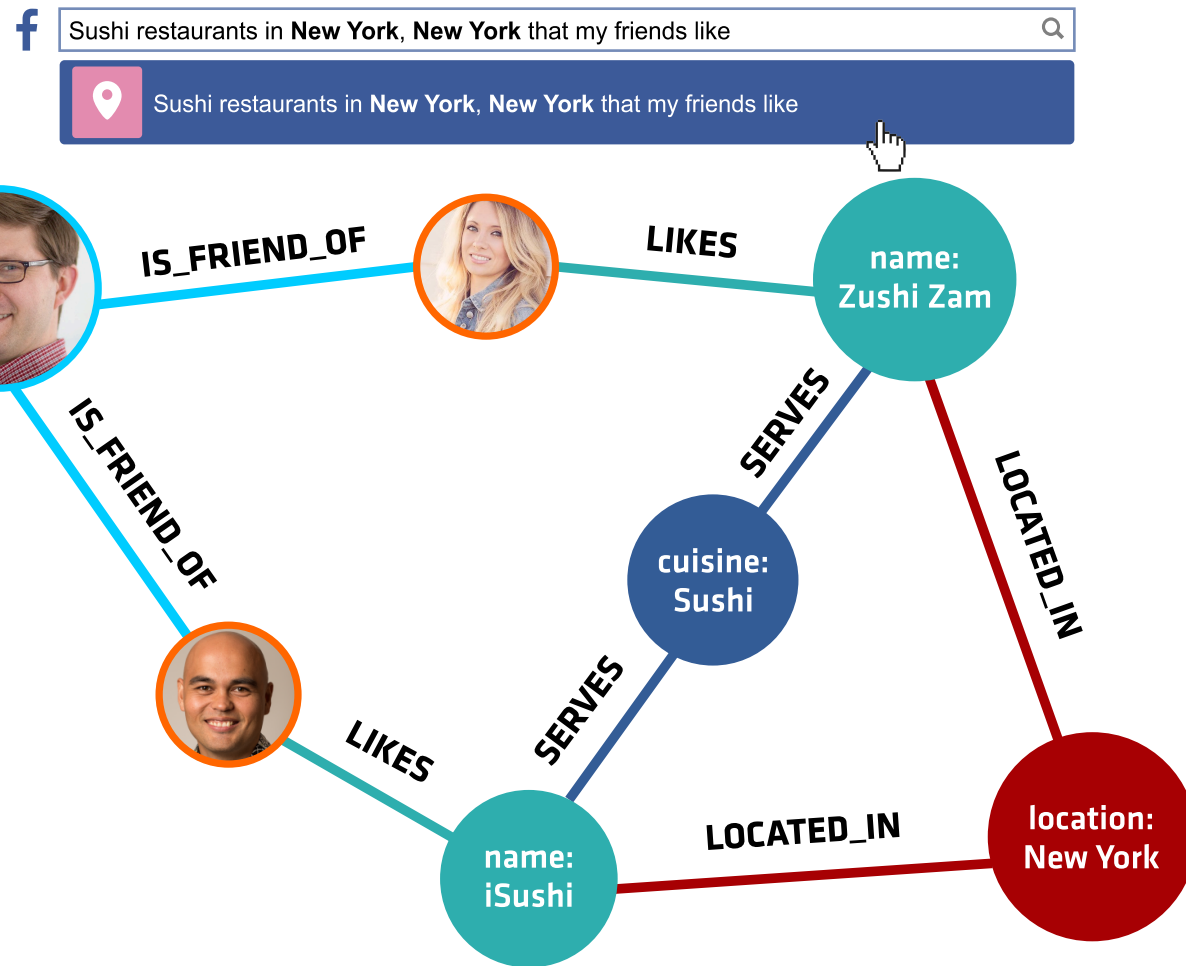
Money laundering



Money laundering



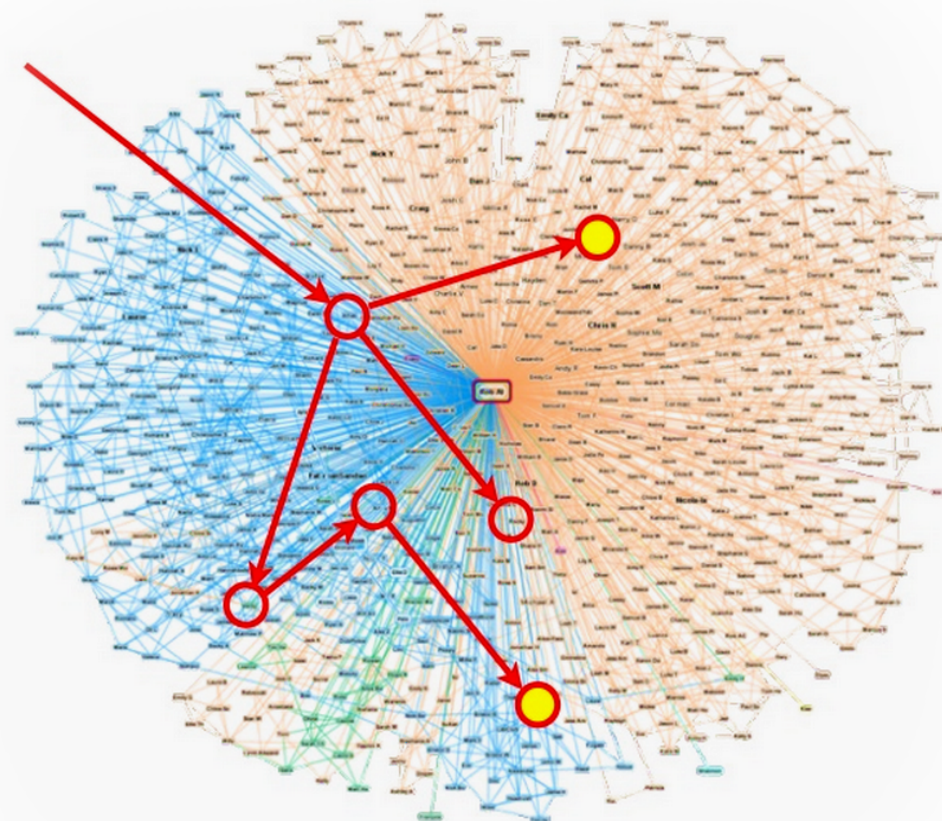
NLP



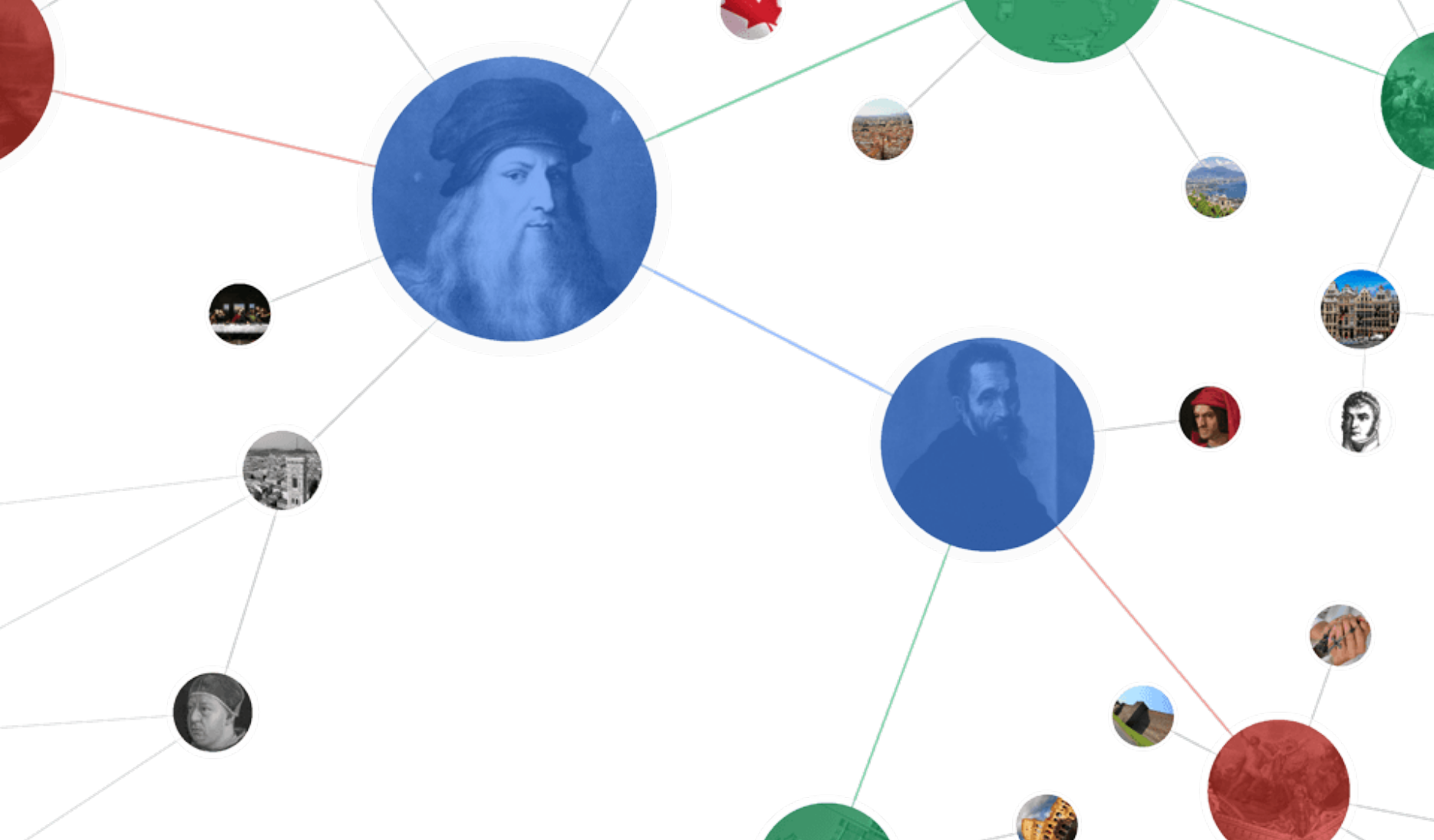
NLP

f Sushi restaurants in **New York, New York** that my friends like

Sushi restaurants in **New York, New York** that my friends like

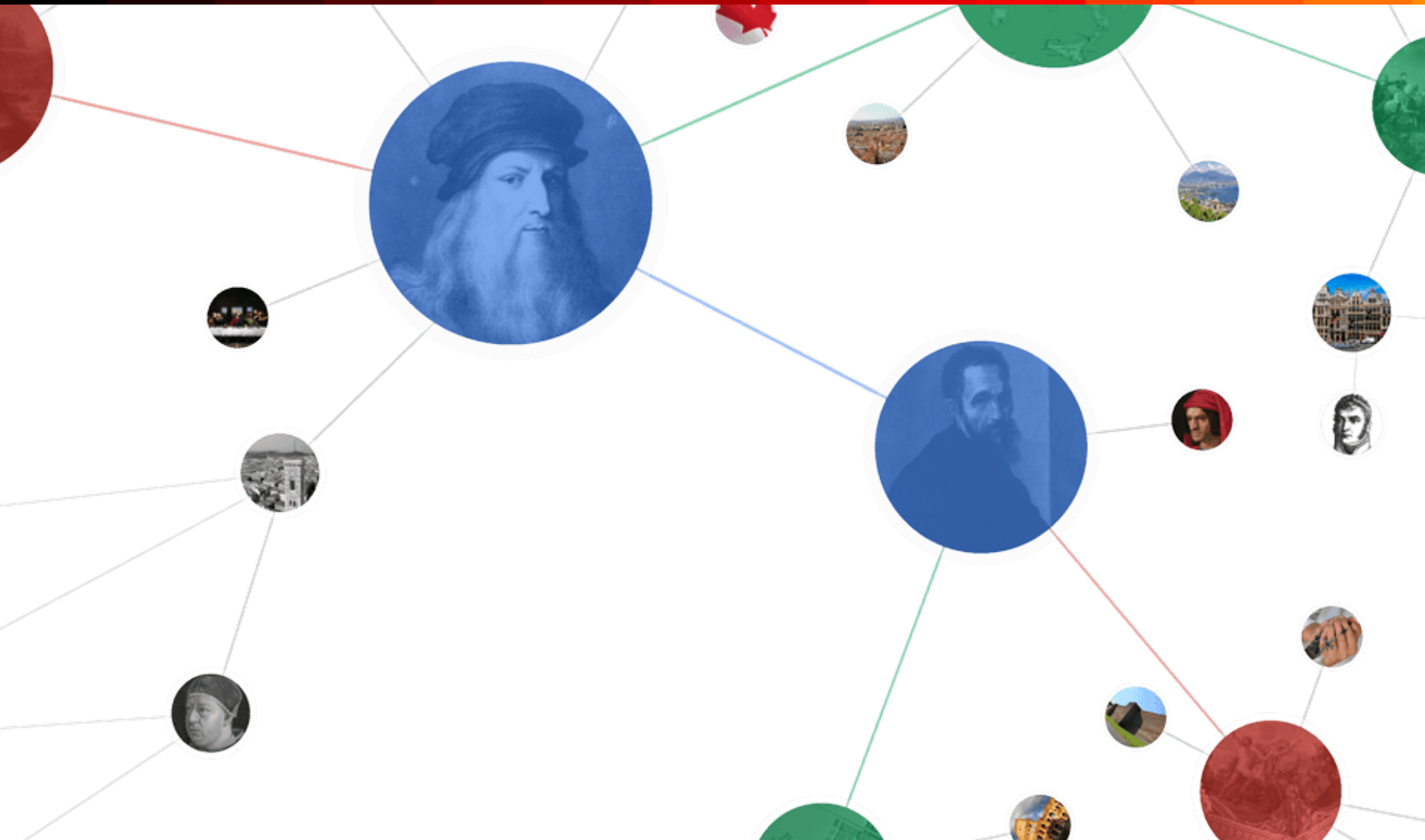


New York Times - apple



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- ...

New York Times



Spock

Fictional Character

Spock, commonly Mr. Spock, is a fictional character in the Star Trek media franchise. Spock was first portrayed by Leonard Nimoy in the original Star Trek series, and also appears in the animated Star ...
[Wikipedia](#)

Played by: [Leonard Nimoy](#)

Species: [Vulcan](#)

Postings: [USS Enterprise \(NCC-1701\)](#), [USS Enterprise \(NCC-1701-A\)](#)

Rank: [Captain](#)

Occupations: [Federation ambassador](#)

Affiliations: [Starfleet](#), [United Federation of Planets](#)

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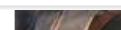
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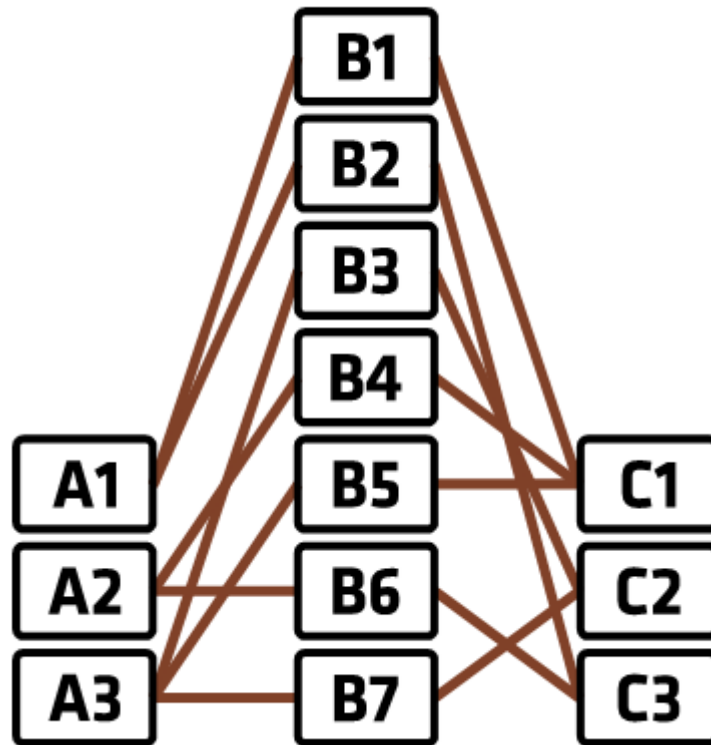
[Isaac Newton](#)



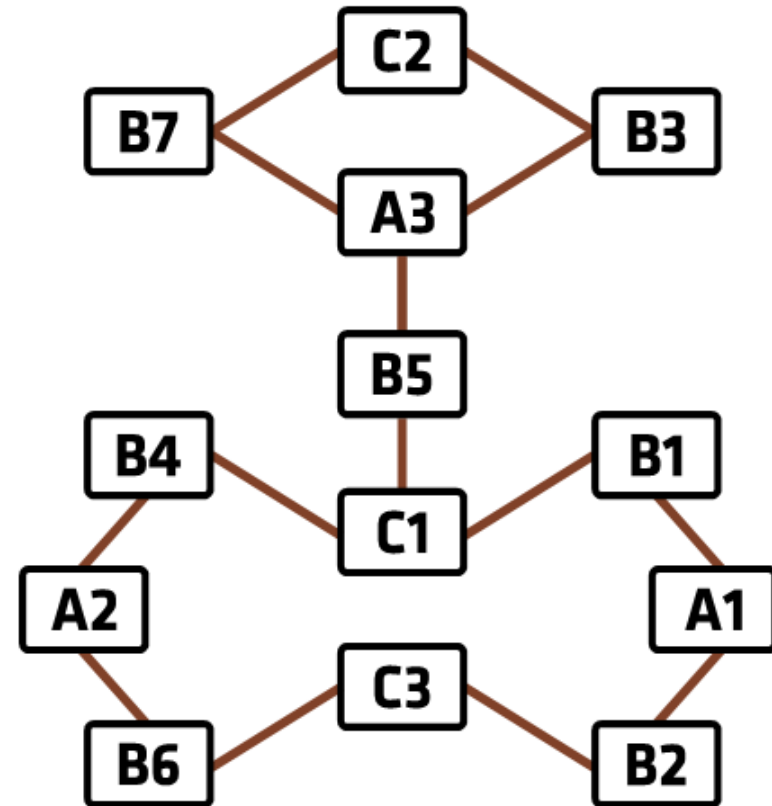
Performance

Performance – think different

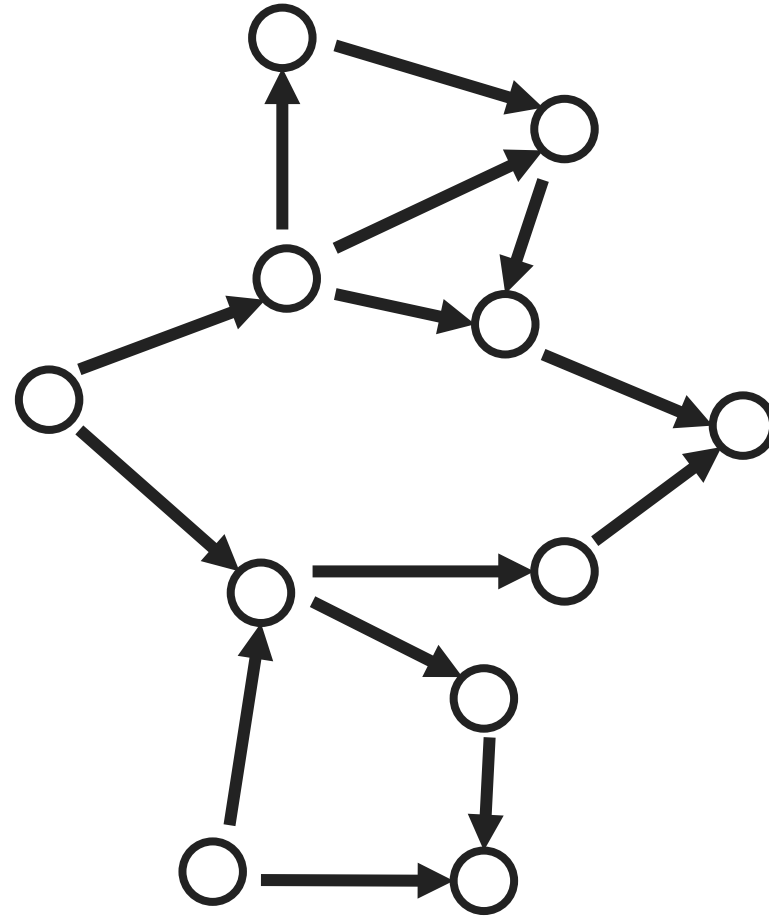
Relational



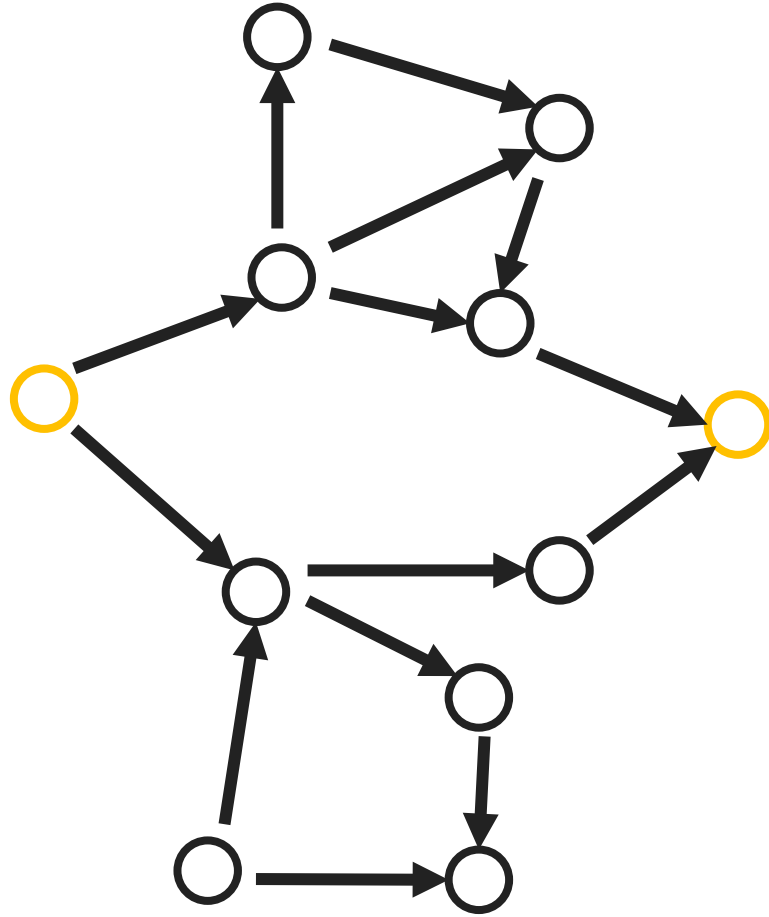
Graph



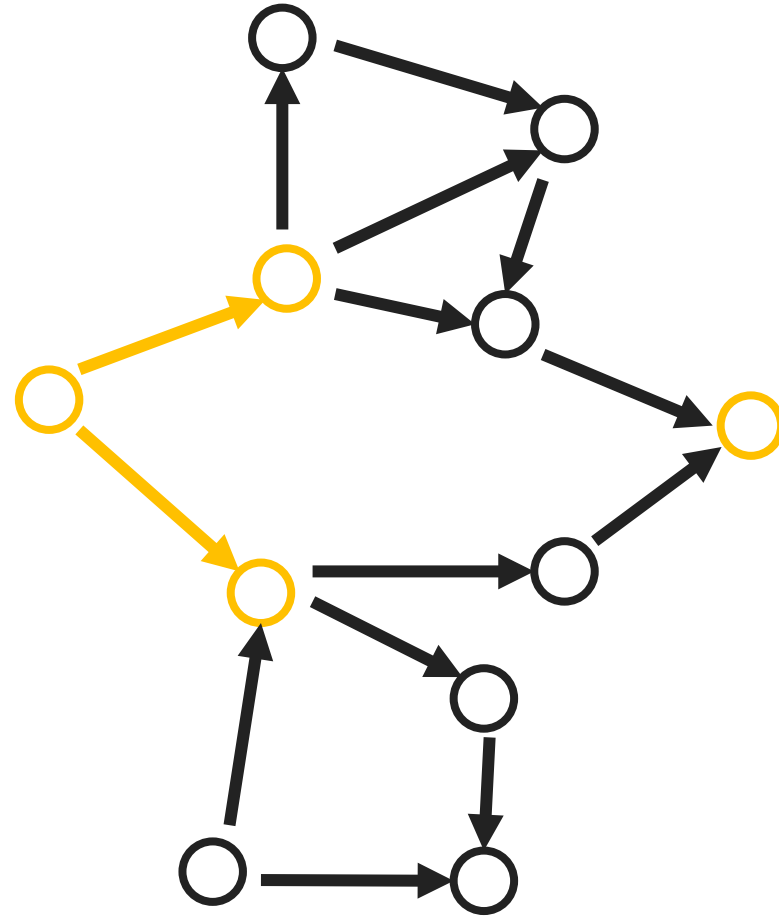
Performance – traversing



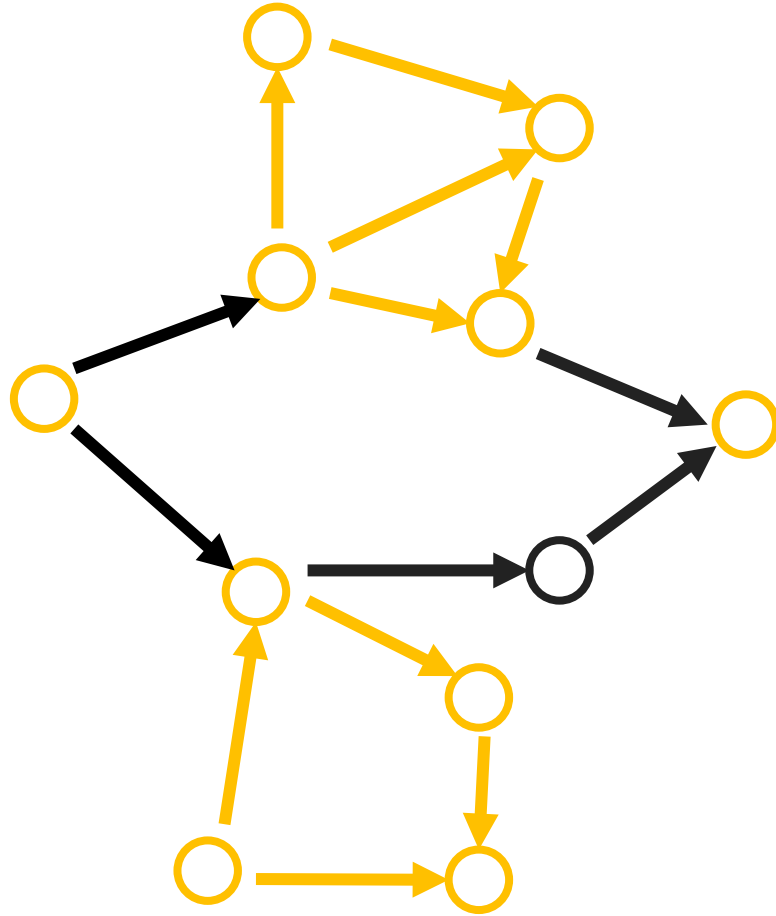
Performance – traversing



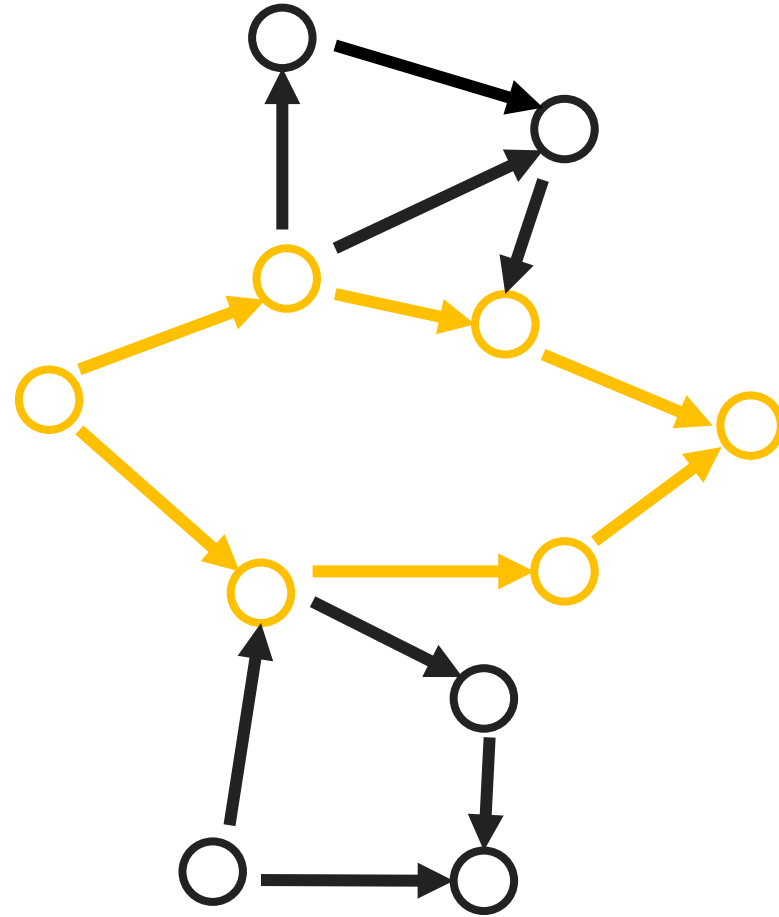
Performance – traversing



Performance – traversing



Performance – traversing



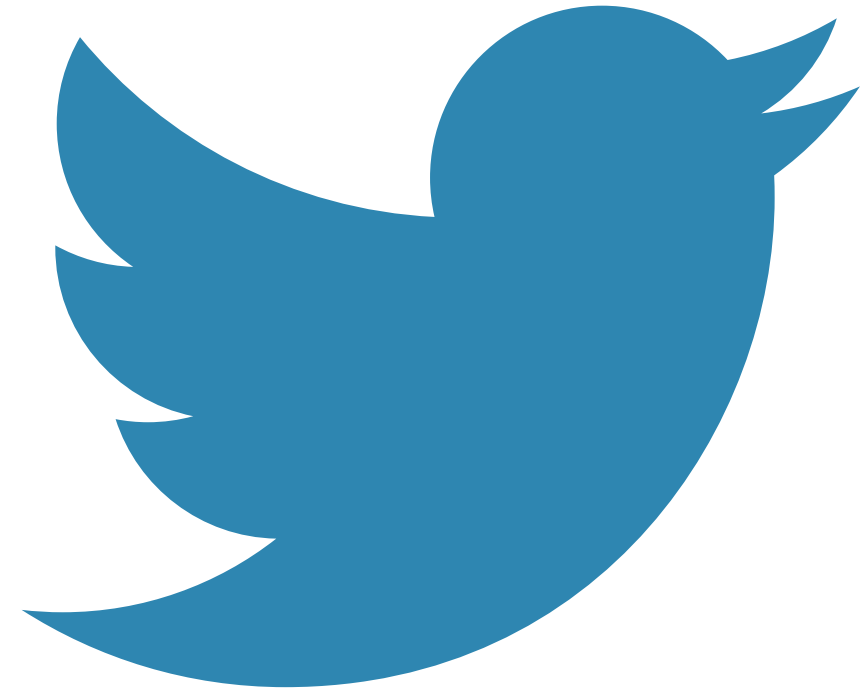
Performance – tests

Twitter from 2009

- 1,67 billion watches
- 41,7 million users

Operations

- Account creation – 1%
- Tweeting – 15%
- Read – 76%
- Recommendations – 7%



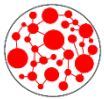
Source: <https://dzone.com/articles/titan-provides-real-time-big>

Performance – tests



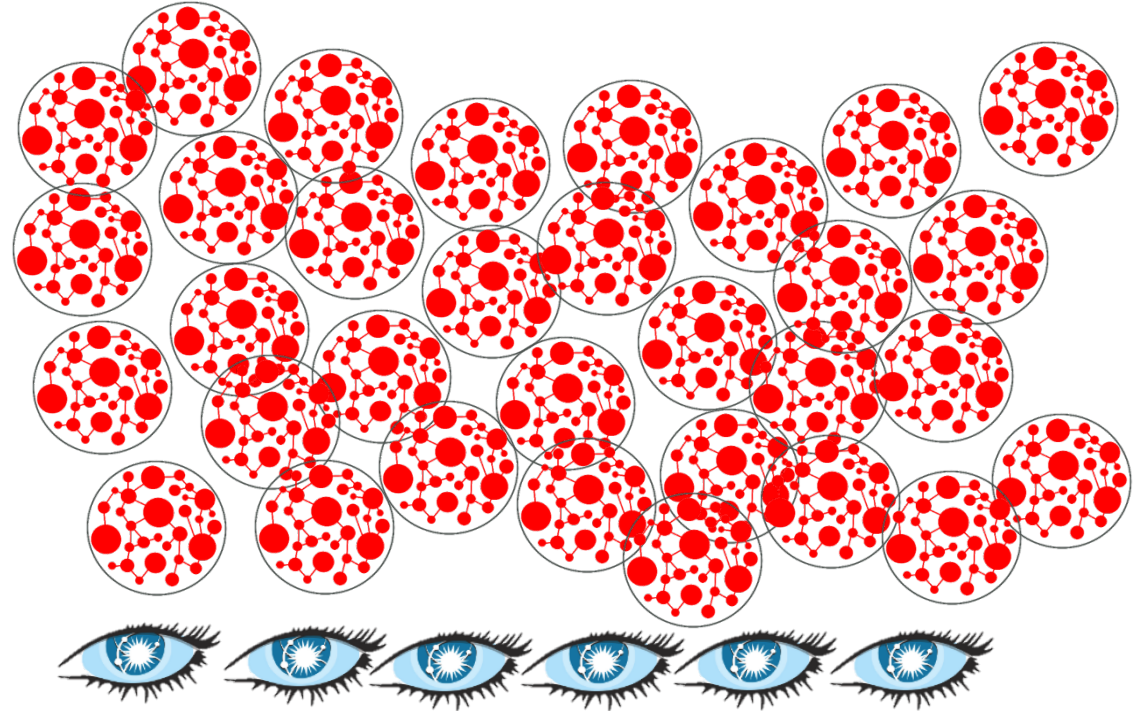
Data storage

- 6 c1.4xl Casandra nodes



Computation

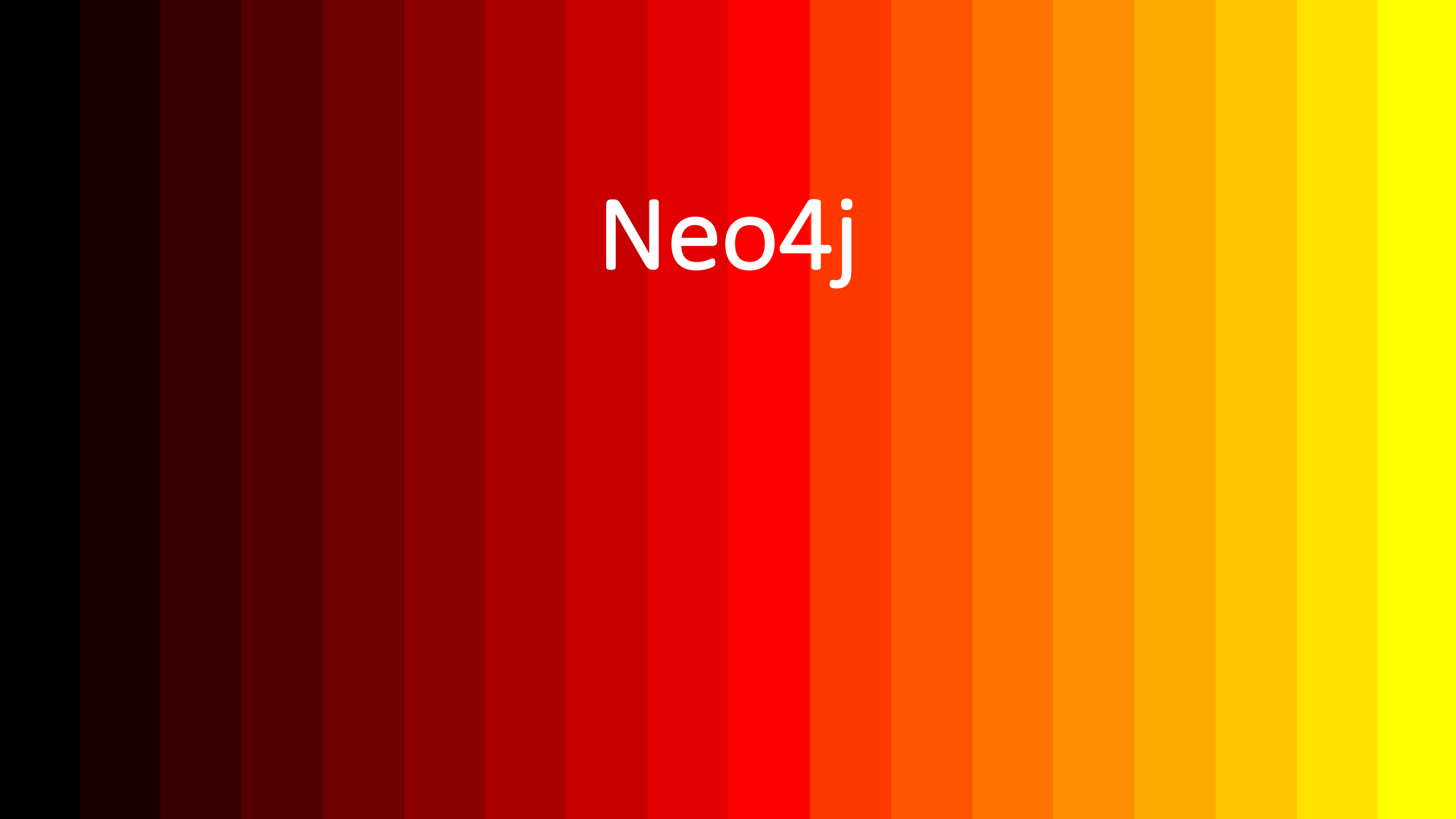
- 40 m1.small
- Write and read



Source: <https://dzone.com/articles/titan-provides-real-time-big>

Performance – tests

Transaction type	Trx numer	Weighted arithmetic mean	Standard deviation
Account creation	379,019	115,15ms	5,88ms
Tweeting	7,580,955	18,54ms	6,34ms
Read	37.936,184	6,29ms	1,62ms
Recommendations	3.793,863	67,65ms	13,89ms
Total	49.690,061		
Time	2,3h		
Average	5.900 trx/sek		
Peek	10,300 trx/sek		

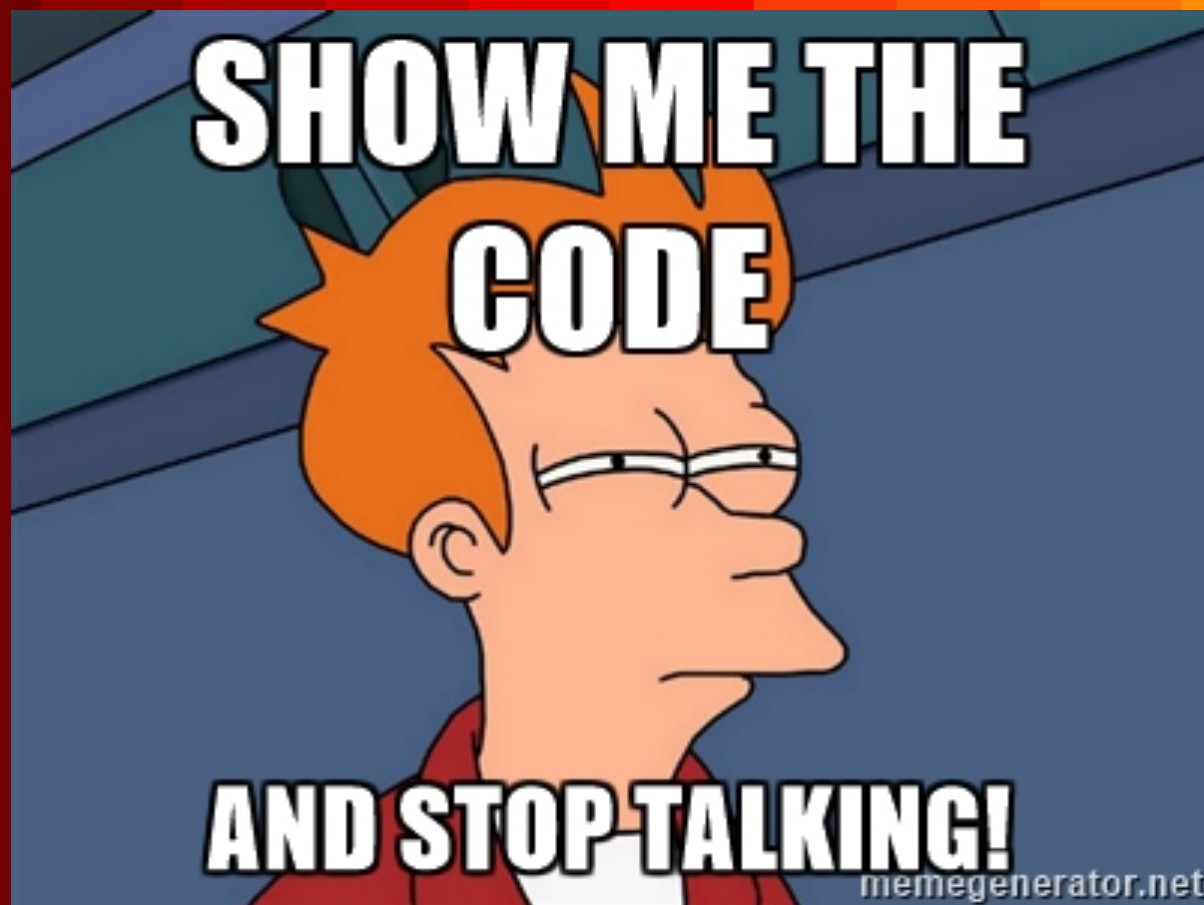
The background of the image consists of vertical stripes of varying widths, each a different shade of red, orange, and yellow, creating a vibrant, multi-colored gradient effect.

Neo4j

Neo4j



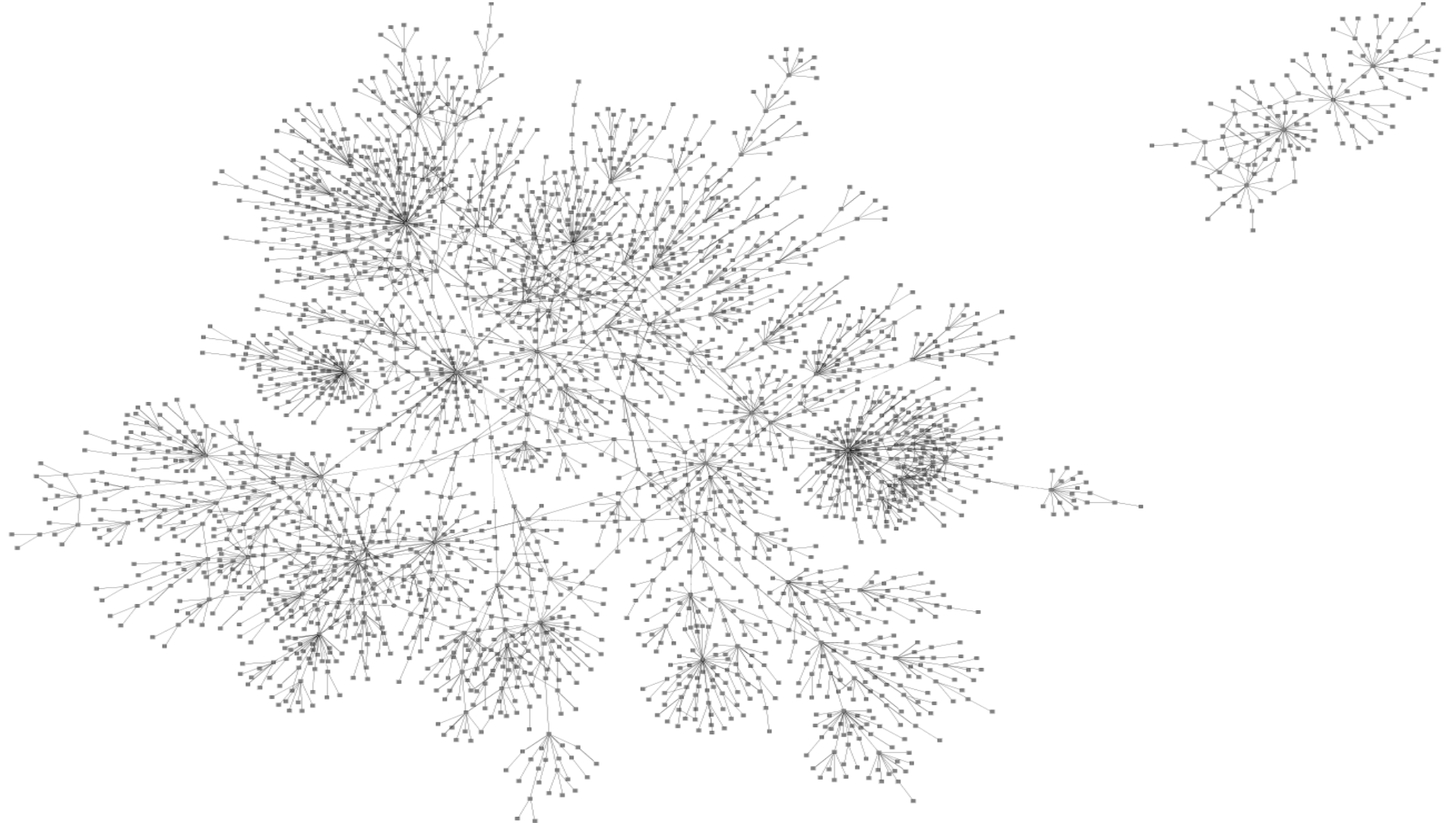
- db-engines.com – 21 in all databases, no 1 in graph databases
- Drivers:
 - Java
 - .NET
 - JavaScript
 - Python
 - Ruby
 - PHP
 - and R, Go, Clojure, Perl, Haskell
- Cypher is a standardized graph query language
- There is a free version



Cypher - cookit

Ingredients:

- ~3000 ingredients
- ~3300 edges
- 9th level deep
- 8 main ingredient groups



Cypher - cookit

Question:

Find recipes that use products from categories **fish (2)** and **sweet drinks (3)**

```
MATCH (r:Recipe) -[:CONTAINS]-> (n:Ingredient),  
(n) -[:FROM|SPECIFICATION*0..9] - (soda:Ingredient {Name:'Sweet drinks'}),  
(n) -[:FROM|SPECIFICATION*0..9] - (fish:Ingredient {Name:'Fish'})  
  
RETURN r,n  
LIMIT 100
```

When to use

When to use

- Hierarchical data
- Relations are more important than data
- Searching patterns in data
- Better data visualization
- Get the sense from data

When NOT to use:

- Data manipulation heavy systems
- Big data $\diamond$ ACID transactions
- **Instead of relational database**

Questions?

