---- Cypher

Prof. Dr. Ingo Claßen

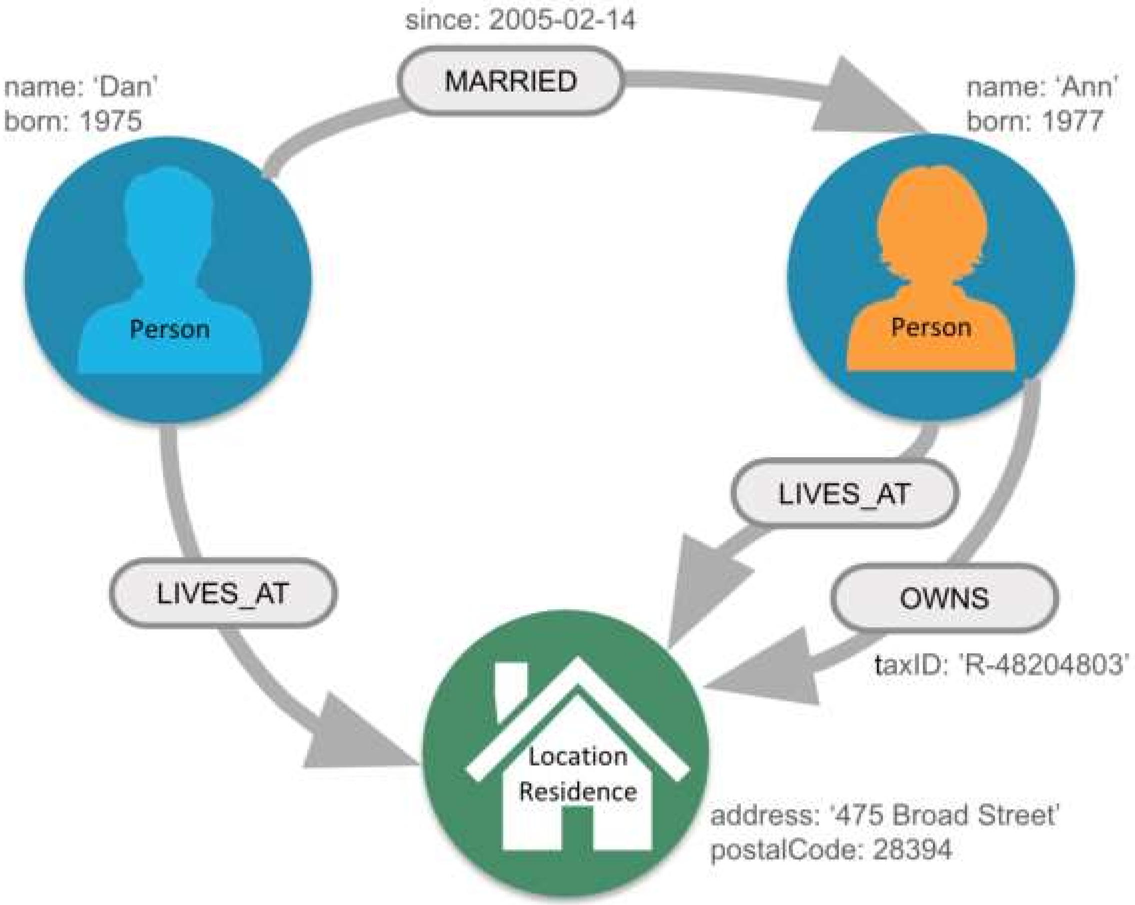
Dienstag, 22. März 2022 08:45

Labeled Property Graph Model

Donnerstag, 30. Dezember 2021 10:26

Labeled Property Graph

- Enthält Knoten (Nodes) und Beziehungen (Relationships)
- Knoten haben Eigenschaften (Properties, Key Value Pairs)
- Knoten sind markiert (labeled, one ore more Labels)
- Beziehungen haben Typen, sind markiert, gerichtet und haben einen Start- und Endknoten
- Beziehungen haben Eigenschaften



Übernommen aus:
Ian Robinson, Jim Webber & Emil Eifrem
Graph Databases, Second Edition,
O'Reilly, 2015

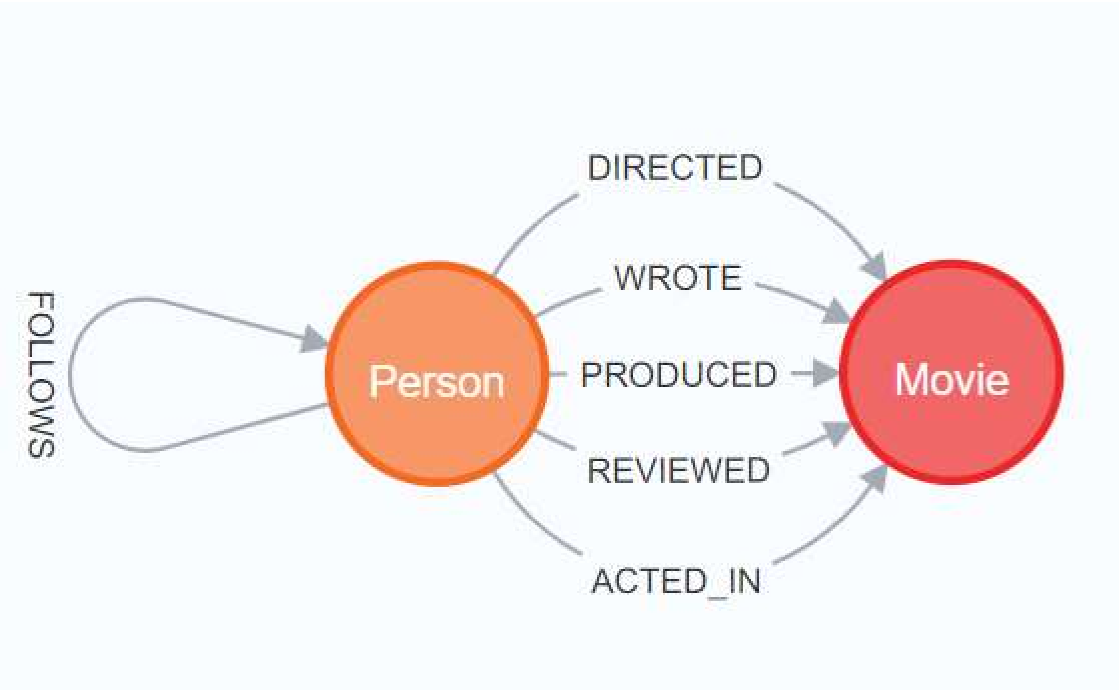
Lizenz

Dienstag, 28. Dezember 2021 16:27

Die folgenden Folien basieren auf Material von Neo4j, welches unter folgender Lizenz zur Verfügung gestellt wird:
https://neo4j.com/docs/license/

Datenmodell

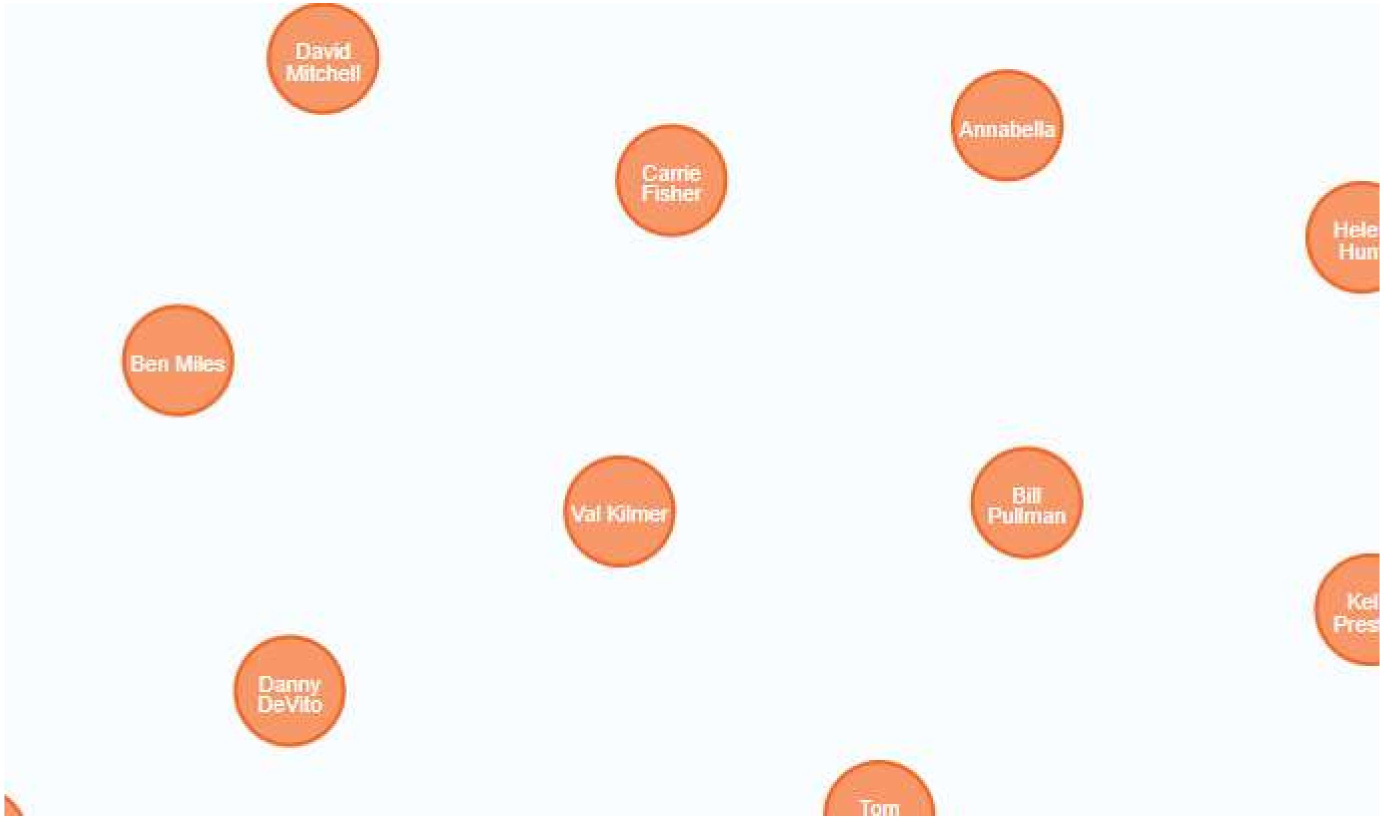
Dienstag, 28. Dezember 2021 16:26



Knoten zu einem Label

Dienstag, 28. Dezember 2021 17:30

```
MATCH (p:Person)
RETURN p
```



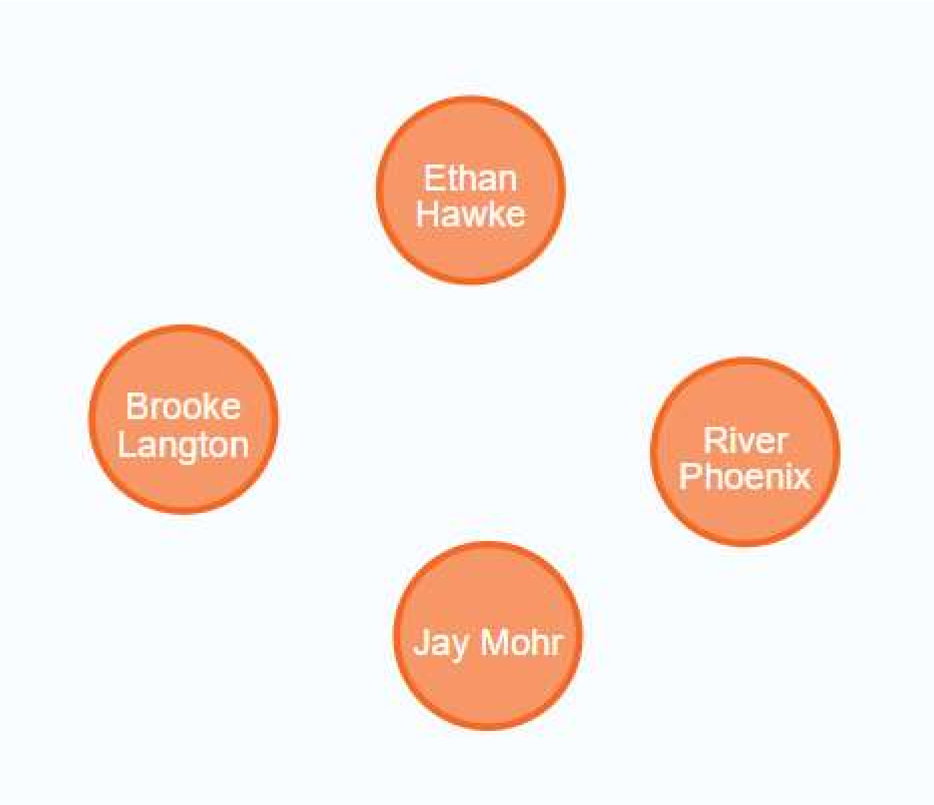
```
{
  "identity": 41,
  "labels": [
    "Person"
  ],
  "properties": {
    "name": "Val Kilmer",
    "born": 1959
  }
}
```

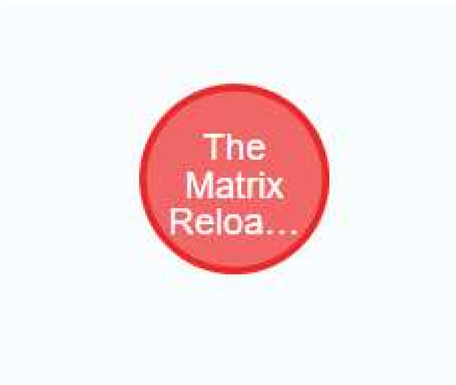
Filter

Mittwoch, 29. Dezember 2021 10:04

```
MATCH (p:Person {born: 1970})
RETURN p
```

```
MATCH (m:Movie {released: 2003, tagline: 'Free your mind'})
RETURN m
```

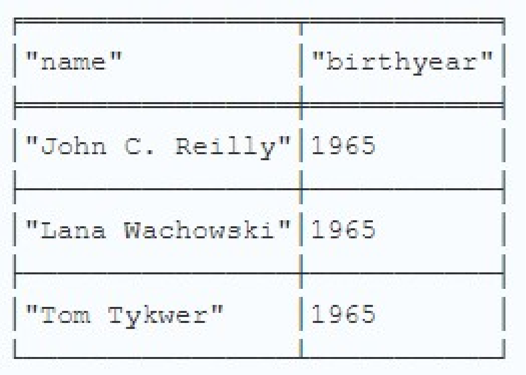




Tabellarische Ergebnisse

Mittwoch, 29. Dezember 2021 10:09

```
MATCH (p:Person {born: 1965})
RETURN p.name AS name, p.born AS birthyear
ORDER BY p.name
```

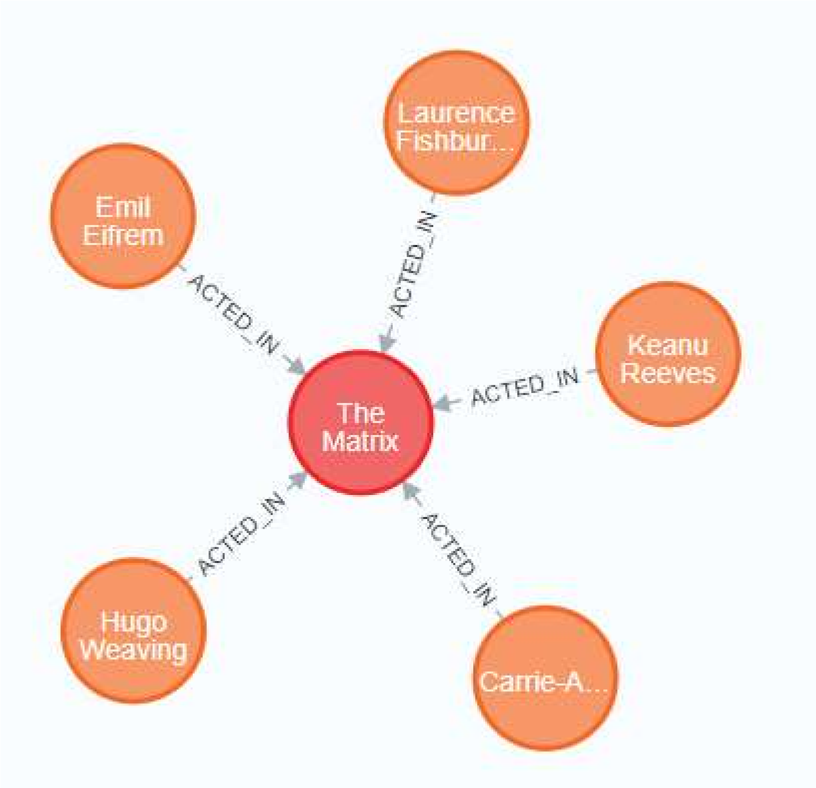


```
╒══════════════════╤═══════════╕
│"name"            │"birthyear"│
╞══════════════════╪═══════════╡
│"John C. Reilly"  │1965       │
├──────────────────┼───────────┤
│"Lana Wachowski"  │1965       │
├──────────────────┼───────────┤
│"Tom Tykwer"      │1965       │
└──────────────────┴───────────┘
```

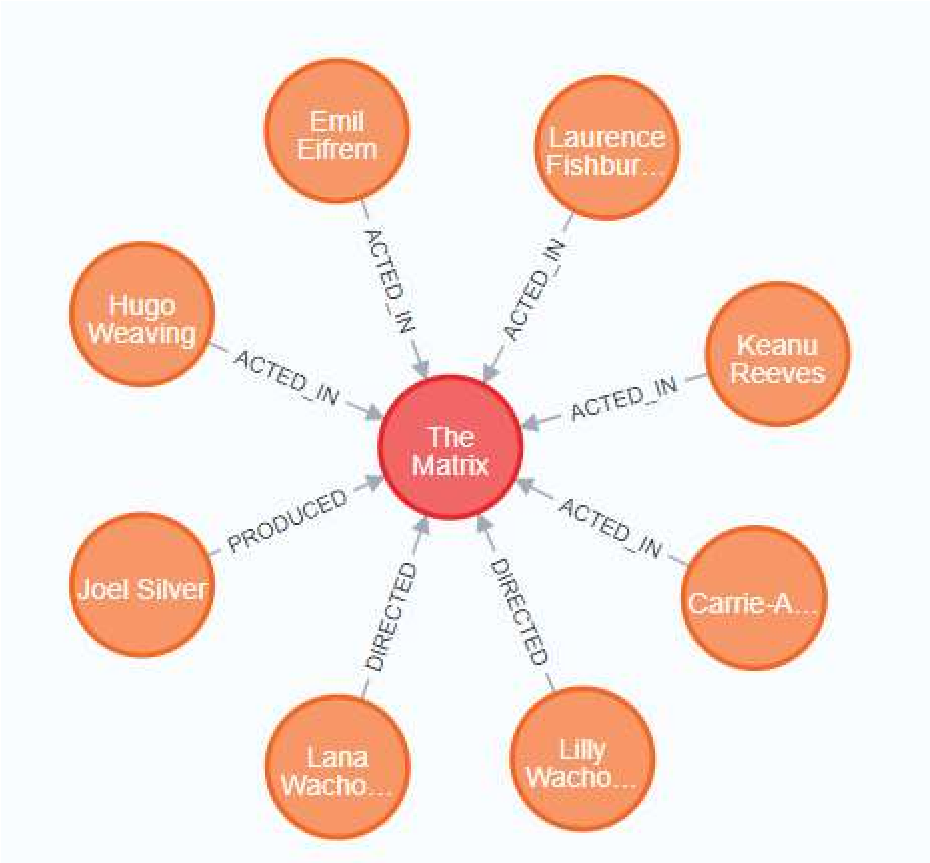
Beziehungen in Abfragen 1

Mittwoch, 29. Dezember 2021 10:12

```
MATCH (p:Person)-[rel:ACTED_IN]->(m:Movie {title: 'The Matrix'})
RETURN p, m
```



```
MATCH (p:Person)-->(m:Movie {title: 'The Matrix'})
RETURN p, m
```

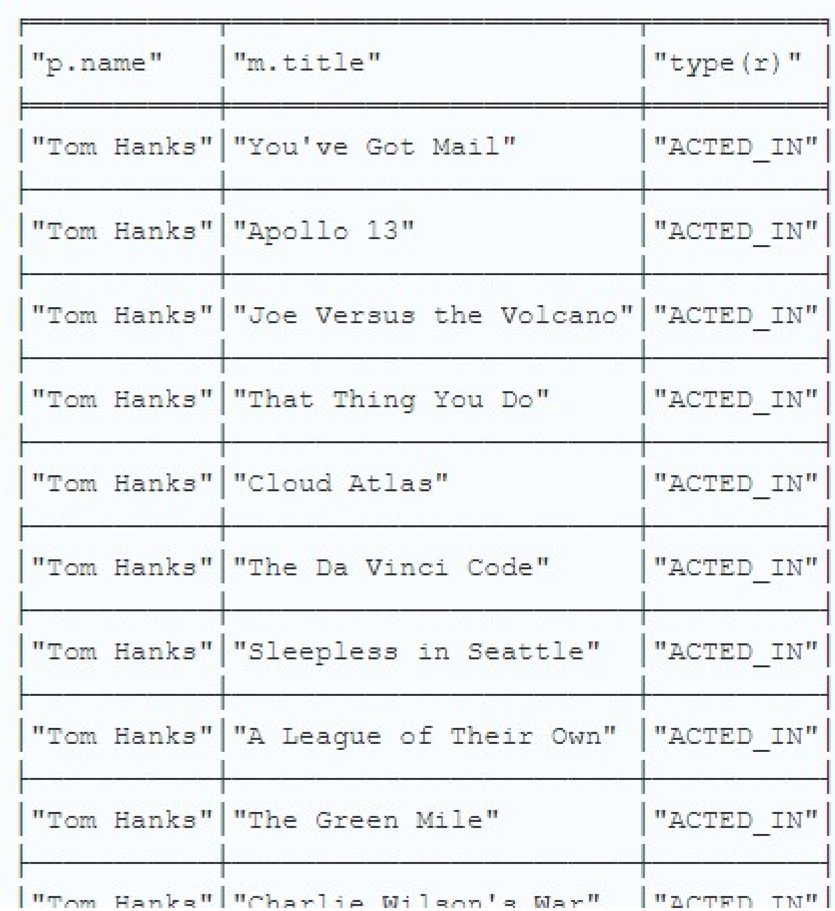


Beziehungen in Abfragen 2

Prof. Dr. Ingo Claßen

Mittwoch, 29. Dezember 2021 10:16

```
MATCH (p:Person {name: 'Tom Hanks'})-[r:ACTED_IN|DIRECTED]->(m:Movie)
RETURN p.name, m.title, type(r)
ORDER BY p.name
```

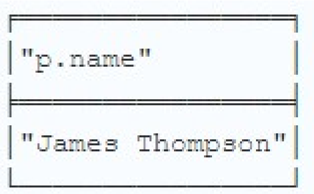


```
╒═══════════╤═════════════════════════╤══════════╕
│"p.name"   │"m.title"                │"type(r)" │
╞═══════════╪═════════════════════════╪══════════╡
│"Tom Hanks"│"You've Got Mail"        │"ACTED_IN"│
├───────────┼─────────────────────────┼──────────┤
│"Tom Hanks"│"Apollo 13"              │"ACTED_IN"│
├───────────┼─────────────────────────┼──────────┤
│"Tom Hanks"│"Joe Versus the Volcano" │"ACTED_IN"│
├───────────┼─────────────────────────┼──────────┤
│"Tom Hanks"│"That Thing You Do"      │"ACTED_IN"│
├───────────┼─────────────────────────┼──────────┤
│"Tom Hanks"│"Cloud Atlas"            │"ACTED_IN"│
├───────────┼─────────────────────────┼──────────┤
│"Tom Hanks"│"The Da Vinci Code"      │"ACTED_IN"│
├───────────┼─────────────────────────┼──────────┤
│"Tom Hanks"│"Sleepless in Seattle"   │"ACTED_IN"│
├───────────┼─────────────────────────┼──────────┤
│"Tom Hanks"│"A League of Their Own"  │"ACTED_IN"│
├───────────┼─────────────────────────┼──────────┤
│"Tom Hanks"│"The Green Mile"         │"ACTED_IN"│
├───────────┼─────────────────────────┼──────────┤
│"Tom Hanks"│"Charlie Wilson's War"   │"ACTED_IN"│
```

Eigenschaften in Beziehungen

Mittwoch, 29. Dezember 2021 10:22

```
MATCH (p:Person)-[:REVIEWED {rating: 65}]->(:Movie {title: 'The Da Vinci Code'})
RETURN p.name
```

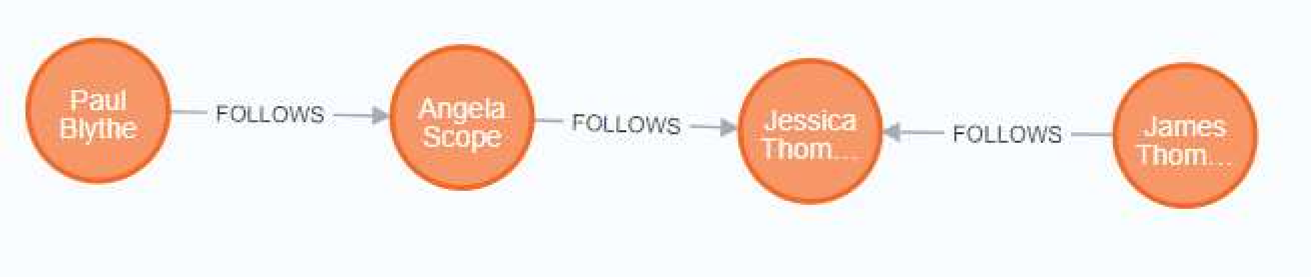


```
╒═════════════════╕
│"p.name"         │
╞═════════════════╡
│"James Thompson" │
└─────────────────┘
```

Pfade 1

Mittwoch, 29. Dezember 2021 10:25

```
MATCH path = (jt:Person {name:'James Thompson'})-[:FOLLOWS*]-(pb:Person {name:'Paul Blythe'})
RETURN path
```



```
{
    "start": {
        "identity": 162,
        "labels": [
            "Person"
        ],
        "properties": {
            "name": "James Thompson"
        }
    },
    "end": {
        "identity": 159,
        "labels": [
            "Person"
        ],
        "properties": {
            "name": "Paul Blythe"
        }
    },
    "segments": [
           ...
     ]
```

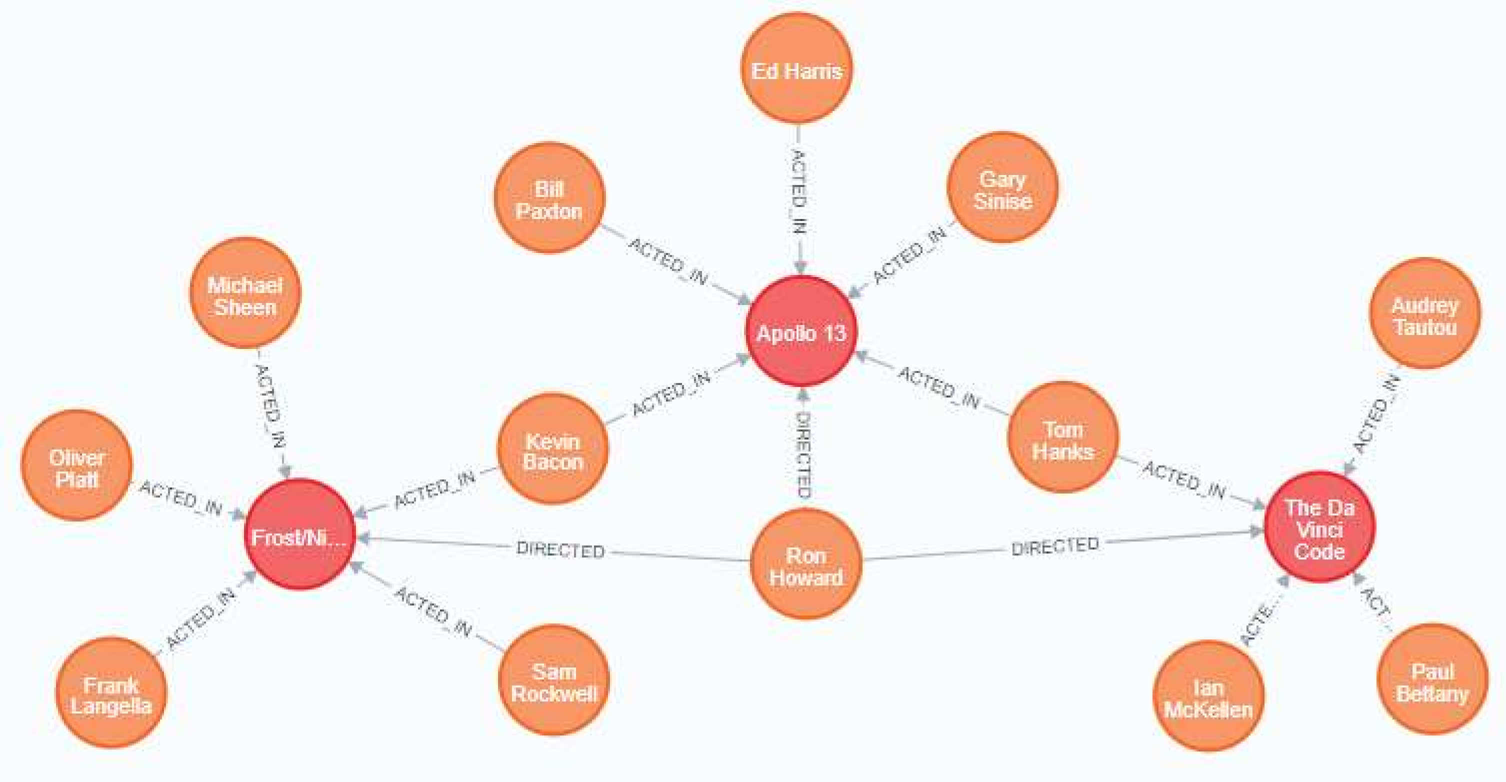
Ein einzelner Pfad

```
{
    "start": {
        "identity": 162,
        "labels": [
            "Person"
        ],
        "properties": {
            "name": "James Thompson"
        }
    },
    "relationship": {
        "identity": 239,
        "start": 162,
        "end": 161,
        "type": "FOLLOWS",
        "properties": {}
    },
    "end": {
        "identity": 161,
        "labels": [
            "Person"
        ],
        "properties": {
            "name": "Jessica Thompson"
        }
    }
},
...
```

Pfade 2

Mittwoch, 29. Dezember 2021 10:41

```
MATCH path = (:Person)-[:ACTED_IN]->(:Movie)<-[:DIRECTED]-(:Person {name:'Ron Howard'})
RETURN path
```

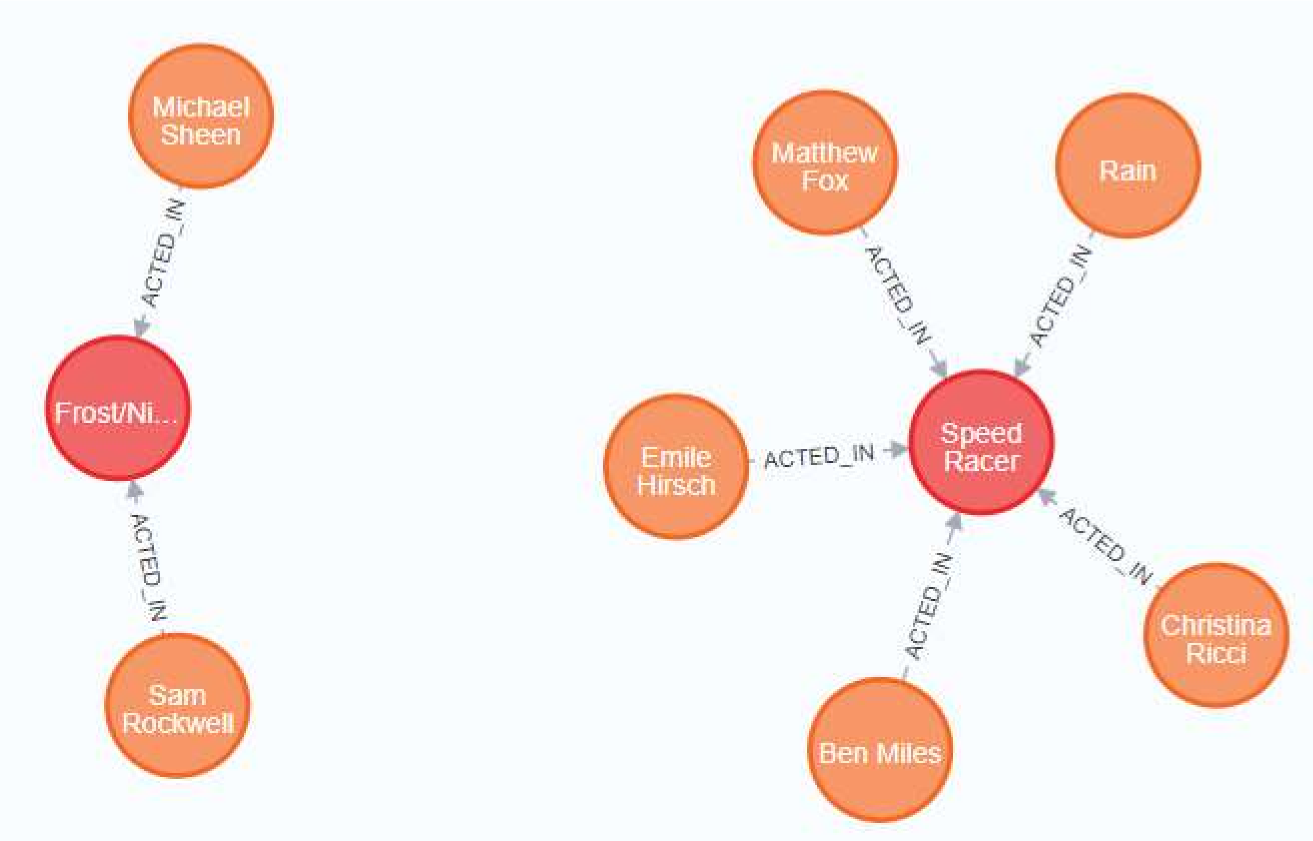


Viele Pfade

Where

Mittwoch, 29. Dezember 2021 10:48

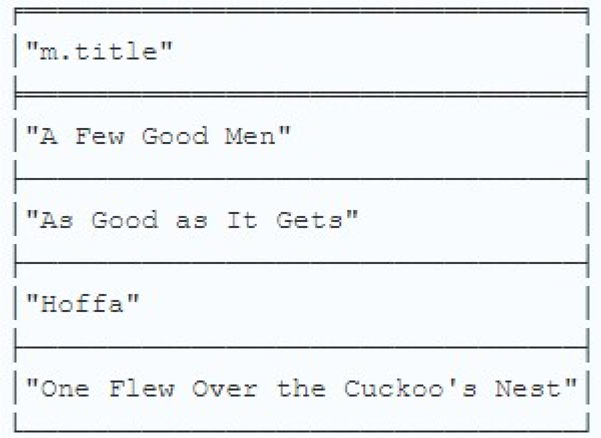
```
MATCH (p:Person)-[:ACTED_IN]->(m:Movie)
WHERE m.released = 2008 AND p.born > 1960
RETURN p, m
```



Null-Werte

Mittwoch, 29. Dezember 2021 10:49

```
MATCH (p:Person)-[:ACTED_IN]->(m:Movie)
WHERE p.name='Jack Nicholson' AND m.tagline IS NOT NULL
RETURN m.title
```

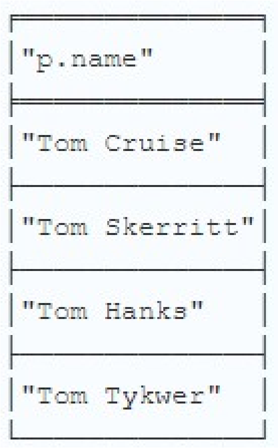


```
╒══════════════════════════════════╕
│"m.title"                         │
╞══════════════════════════════════╡
│"A Few Good Men"                  │
├──────────────────────────────────┤
│"As Good as It Gets"              │
├──────────────────────────────────┤
│"Hoffa"                           │
├──────────────────────────────────┤
│"One Flew Over the Cuckoo's Nest" │
└──────────────────────────────────┘
```

Reguläre Ausdrücke

Mittwoch, 29. Dezember 2021 10:52

```
MATCH (p:Person)
WHERE p.name =~'Tom.*'
RETURN p.name
```

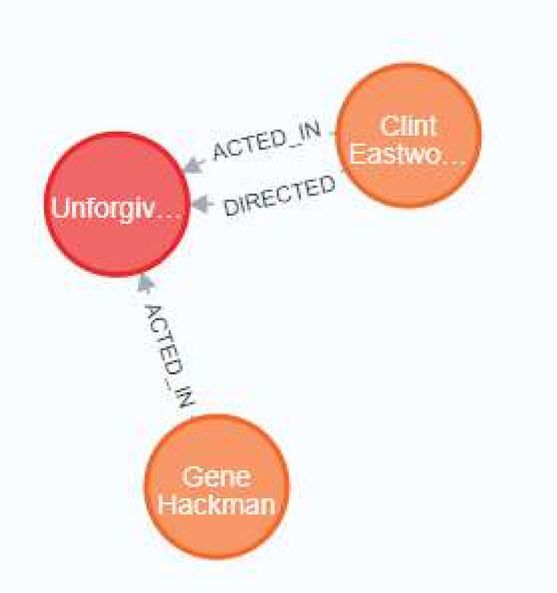


```
╒═══════════════╕
│"p.name"       │
╞═══════════════╡
│"Tom Cruise"   │
├───────────────┤
│"Tom Skerritt" │
├───────────────┤
│"Tom Hanks"    │
├───────────────┤
│"Tom Tykwer"   │
└───────────────┘
```

Pfade in Bedingungen

Dienstag, 28. Dezember 2021 16:20

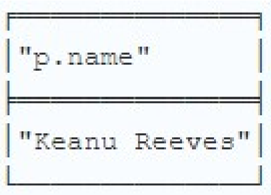
```
MATCH (gene:Person)-[:ACTED_IN]->(m:Movie)<-[:ACTED_IN]-(other:Person)
WHERE gene.name = 'Gene Hackman'
AND exists((other)-[:DIRECTED]->(m))
RETURN gene, other, m
```



Listenwertige Eigenschaften

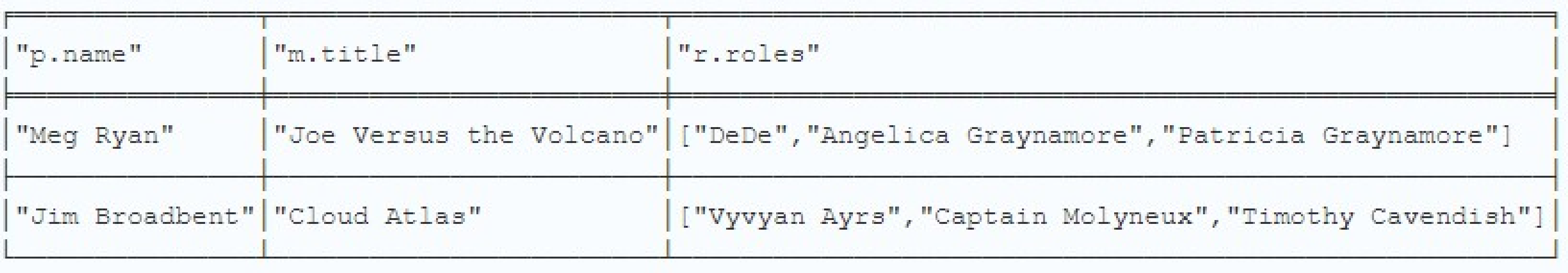
Mittwoch, 29. Dezember 2021 10:55

```
MATCH (p:Person)-[r:ACTED_IN]->(m:Movie)
WHERE 'Neo' IN r.roles AND m.title = 'The Matrix'
RETURN p.name
```



```
╒══════════════╕
│"p.name"      │
╞══════════════╡
│"Keanu Reeves"│
└──────────────┘
```

```
MATCH (p:Person)-[r:ACTED_IN]->(m:Movie)
WHERE size(r.roles)=3
RETURN p.name, m.title, r.roles
```

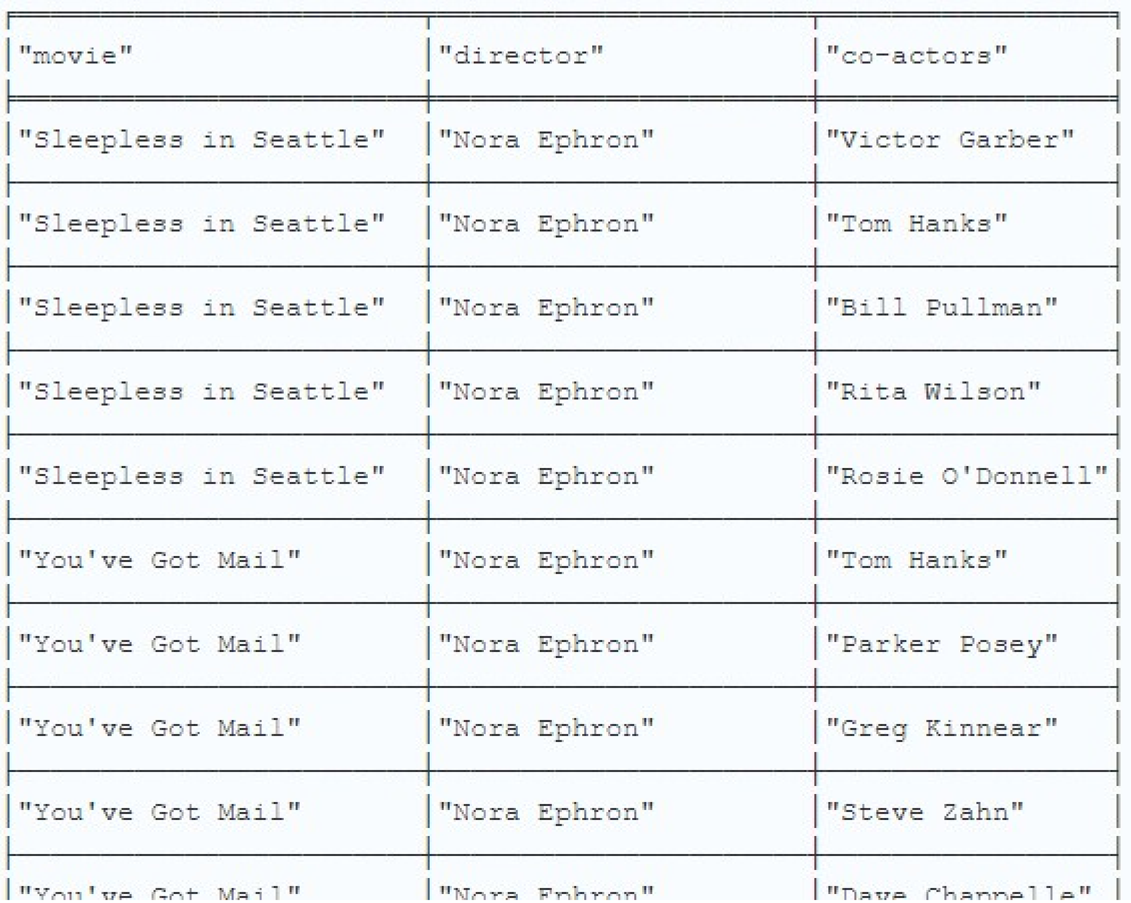


```
╒═══════════════╤═════════════════════════╤═══════════════════════════════════════════════════════╕
│"p.name"       │"m.title"                │"r.roles"                                              │
╞═══════════════╪═════════════════════════╪═══════════════════════════════════════════════════════╡
│"Meg Ryan"     │"Joe Versus the Volcano"│["DeDe","Angelica Graynamore","Patricia Graynamore"]    │
├───────────────┼─────────────────────────┼───────────────────────────────────────────────────────┤
│"Jim Broadbent"│"Cloud Atlas"            │["Vyvyan Ayrs","Captain Molyneux","Timothy Cavendish"]│
└───────────────┴─────────────────────────┴───────────────────────────────────────────────────────┘
```

Musterkombinationen

Mittwoch, 29. Dezember 2021 11:03

```
MATCH
  (meg:Person)-[:ACTED_IN]->(m:Movie)<-[:DIRECTED]-(d:Person),
  (other:Person)-[:ACTED_IN]->(m)
WHERE meg.name = 'Meg Ryan'
RETURN m.title as movie, d.name AS director, other.name AS `co-actors`
```



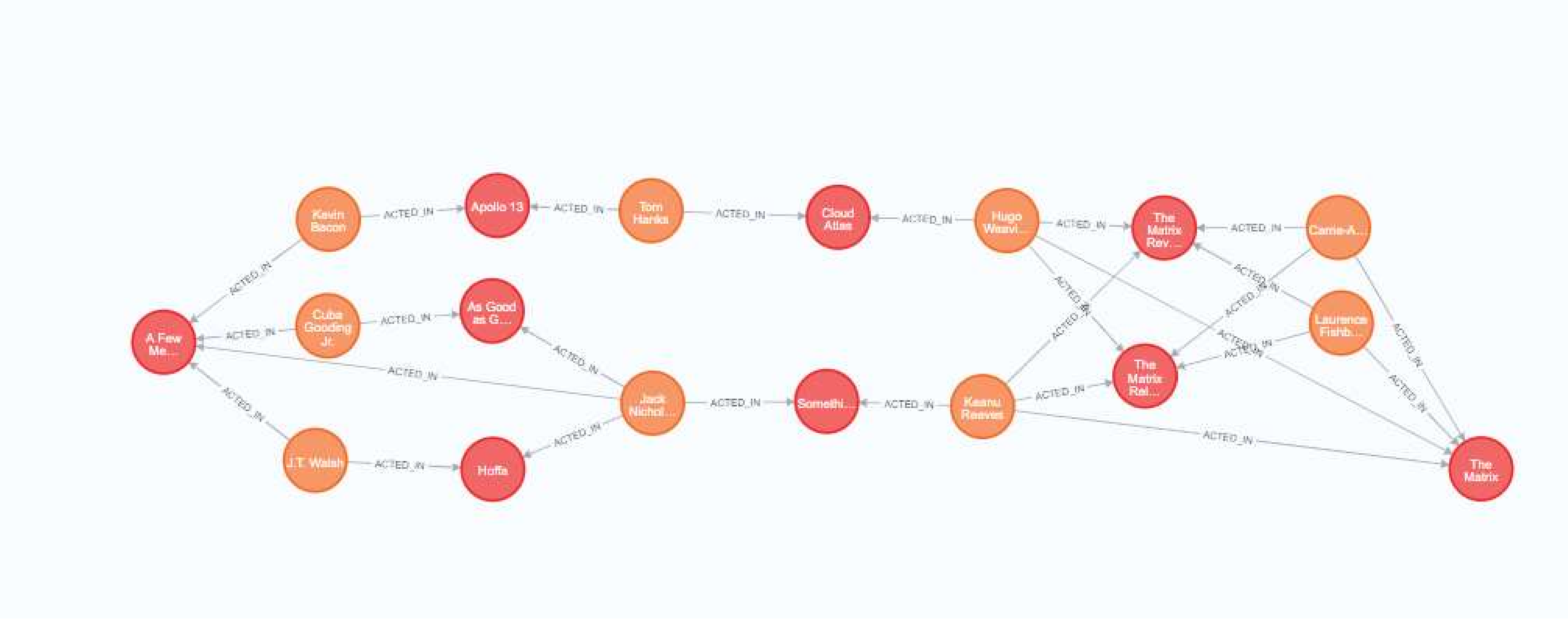
```
╒═════════════════════════╤═══════════════════════╤══════════════════╕
│"movie"                  │"director"             │"co-actors"       │
╞═════════════════════════╪═══════════════════════╪══════════════════╡
│"Sleepless in Seattle"   │"Nora Ephron"          │"Victor Garber"   │
├─────────────────────────┼───────────────────────┼──────────────────┤
│"Sleepless in Seattle"   │"Nora Ephron"          │"Tom Hanks"       │
├─────────────────────────┼───────────────────────┼──────────────────┤
│"Sleepless in Seattle"   │"Nora Ephron"          │"Bill Pullman"    │
├─────────────────────────┼───────────────────────┼──────────────────┤
│"Sleepless in Seattle"   │"Nora Ephron"          │"Rita Wilson"     │
├─────────────────────────┼───────────────────────┼──────────────────┤
│"Sleepless in Seattle"   │"Nora Ephron"          │"Rosie O'Donnell" │
├─────────────────────────┼───────────────────────┼──────────────────┤
│"You've Got Mail"        │"Nora Ephron"          │"Tom Hanks"       │
├─────────────────────────┼───────────────────────┼──────────────────┤
│"You've Got Mail"        │"Nora Ephron"          │"Parker Posey"    │
├─────────────────────────┼───────────────────────┼──────────────────┤
│"You've Got Mail"        │"Nora Ephron"          │"Greg Kinnear"    │
├─────────────────────────┼───────────────────────┼──────────────────┤
│"You've Got Mail"        │"Nora Ephron"          │"Steve Zahn"      │
├─────────────────────────┼───────────────────────┼──────────────────┤
│"You've Got Mail"        │"Nora Ephron"          │"Dave Chappelle"  │
```

Pfade viariabler Länge

Mittwoch, 29. Dezember 2021 11:07

*	beliebig lang
*2..4	zwischen 2 und 4
*..6	bis 6
*3..	3 und länger

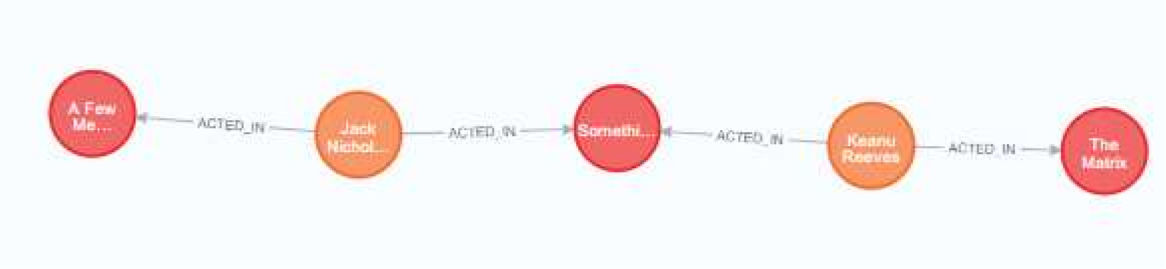
```
MATCH p = ((m1:Movie)-[:ACTED_IN*..6]-(m2:Movie))
WHERE m1.title = 'A Few Good Men' AND m2.title = 'The Matrix'
RETURN p
```



Kürzester Pfad

Mittwoch, 29. Dezember 2021 11:07

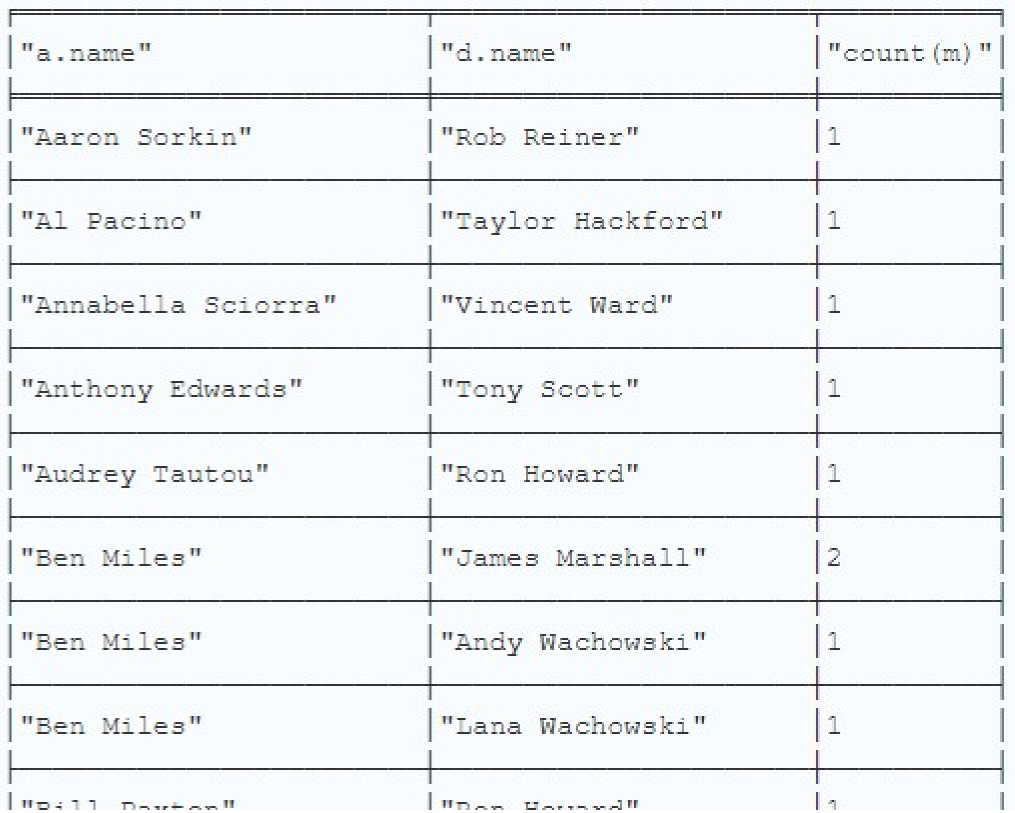
```
MATCH p = shortestPath((m1:Movie)-[:ACTED_IN*]-(m2:Movie))
WHERE m1.title = 'A Few Good Men' AND
m2.title = 'The Matrix'
RETURN p
```



Aggregationen 1

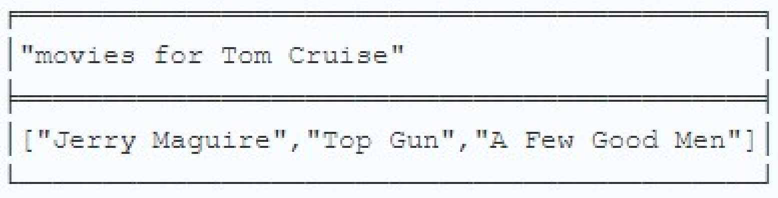
Mittwoch, 29. Dezember 2021 11:10

```
MATCH
  (a:Person)-[:ACTED_IN]->(m:Movie)<-[:DIRECTED]-(d:Person)
RETURN a.name, d.name, count(m)
ORDER BY a.name
```



```
╒══════════════════════════╤═══════════════════════╤══════════╕
│"a.name"                  │"d.name"               │"count(m)"│
╞══════════════════════════╪═══════════════════════╪══════════╡
│"Aaron Sorkin"            │"Rob Reiner"           │1         │
├──────────────────────────┼───────────────────────┼──────────┤
│"Al Pacino"               │"Taylor Hackford"      │1         │
├──────────────────────────┼───────────────────────┼──────────┤
│"Annabella Sciorra"       │"Vincent Ward"         │1         │
├──────────────────────────┼───────────────────────┼──────────┤
│"Anthony Edwards"         │"Tony Scott"           │1         │
├──────────────────────────┼───────────────────────┼──────────┤
│"Audrey Tautou"           │"Ron Howard"           │1         │
├──────────────────────────┼───────────────────────┼──────────┤
│"Ben Miles"               │"James Marshall"       │2         │
├──────────────────────────┼───────────────────────┼──────────┤
│"Ben Miles"               │"Andy Wachowski"       │1         │
├──────────────────────────┼───────────────────────┼──────────┤
│"Ben Miles"               │"Lana Wachowski"       │1         │
├──────────────────────────┼───────────────────────┼──────────┤
│"Bill Paxton"             │"Ron Howard"           │1         │
```

```
MATCH
  (p:Person)-[:ACTED_IN]->(m:Movie)
WHERE p.name = 'Tom Cruise'
RETURN collect(m.title) AS `movies for Tom Cruise`
```

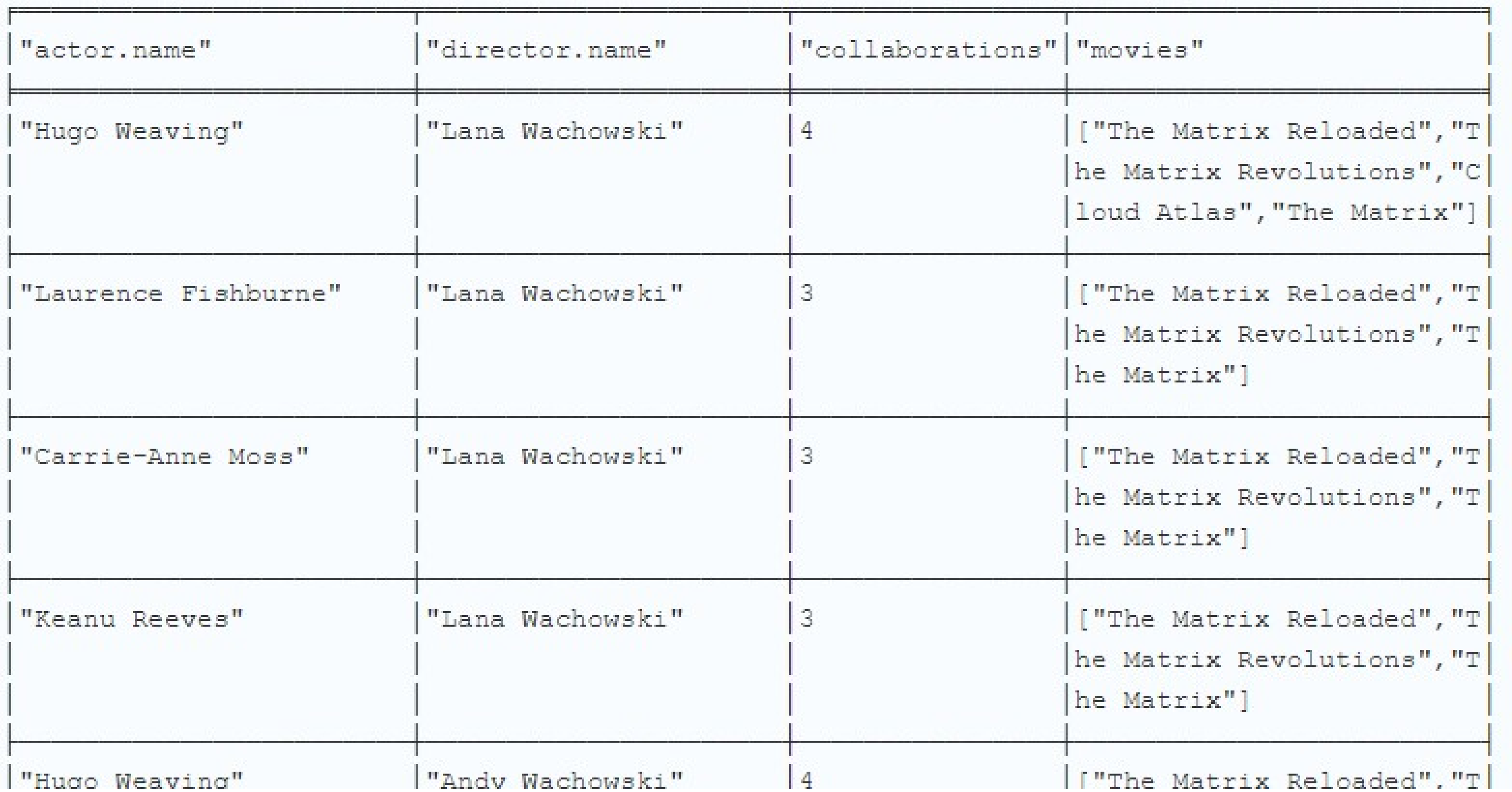


```
╒═════════════════════════════════════════════╕
│"movies for Tom Cruise"                      │
╞═════════════════════════════════════════════╡
│["Jerry Maguire","Top Gun","A Few Good Men"]│
└─────────────────────────────────────────────┘
```

Aggregationen 2

Mittwoch, 29. Dezember 2021 11:15

```
MATCH (actor:Person)-[:ACTED_IN]->(m:Movie)<-[:DIRECTED]-(director:Person)
RETURN actor.name, director.name, count(m) AS collaborations, collect(m.title) AS movies
```

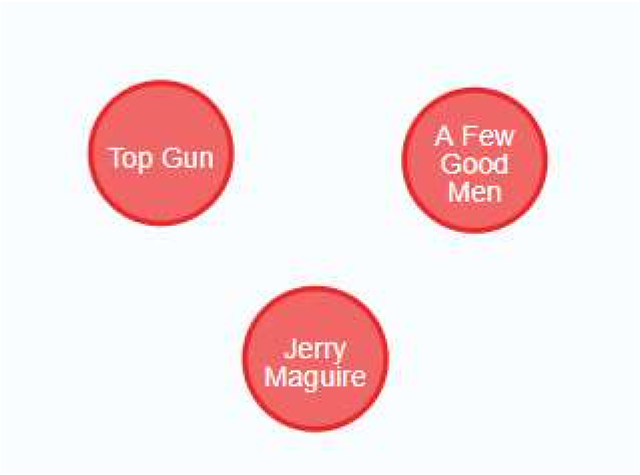


```
╒═════════════════════════╤═══════════════════════╤════════════════╤═════════════════════════╕
│"actor.name"             │"director.name"        │"collaborations"│"movies"                 │
╞═════════════════════════╪═══════════════════════╪════════════════╪═════════════════════════╡
│"Hugo Weaving"           │"Lana Wachowski"       │4               │["The Matrix Reloaded","T│
│                         │                       │                │he Matrix Revolutions","C│
│                         │                       │                │loud Atlas","The Matrix"]│
├─────────────────────────┼───────────────────────┼────────────────┼─────────────────────────┤
│"Laurence Fishburne"     │"Lana Wachowski"       │3               │["The Matrix Reloaded","T│
│                         │                       │                │he Matrix Revolutions","T│
│                         │                       │                │he Matrix"]              │
├─────────────────────────┼───────────────────────┼────────────────┼─────────────────────────┤
│"Carrie-Anne Moss"       │"Lana Wachowski"       │3               │["The Matrix Reloaded","T│
│                         │                       │                │he Matrix Revolutions","T│
│                         │                       │                │he Matrix"]              │
├─────────────────────────┼───────────────────────┼────────────────┼─────────────────────────┤
│"Keanu Reeves"           │"Lana Wachowski"       │3               │["The Matrix Reloaded","T│
│                         │                       │                │he Matrix Revolutions","T│
│                         │                       │                │he Matrix"]              │
├─────────────────────────┼───────────────────────┼────────────────┼─────────────────────────┤
│"Hugo Weaving"           │"Andy Wachowski"       │4               │["The Matrix Reloaded","T│
```

Listen von Knoten

Mittwoch, 29. Dezember 2021 11:12

```
MATCH (p:Person)-[:ACTED_IN]->(m:Movie)
WHERE p.name = 'Tom Cruise'
RETURN collect(m) AS `movies for Tom Cruise`
```

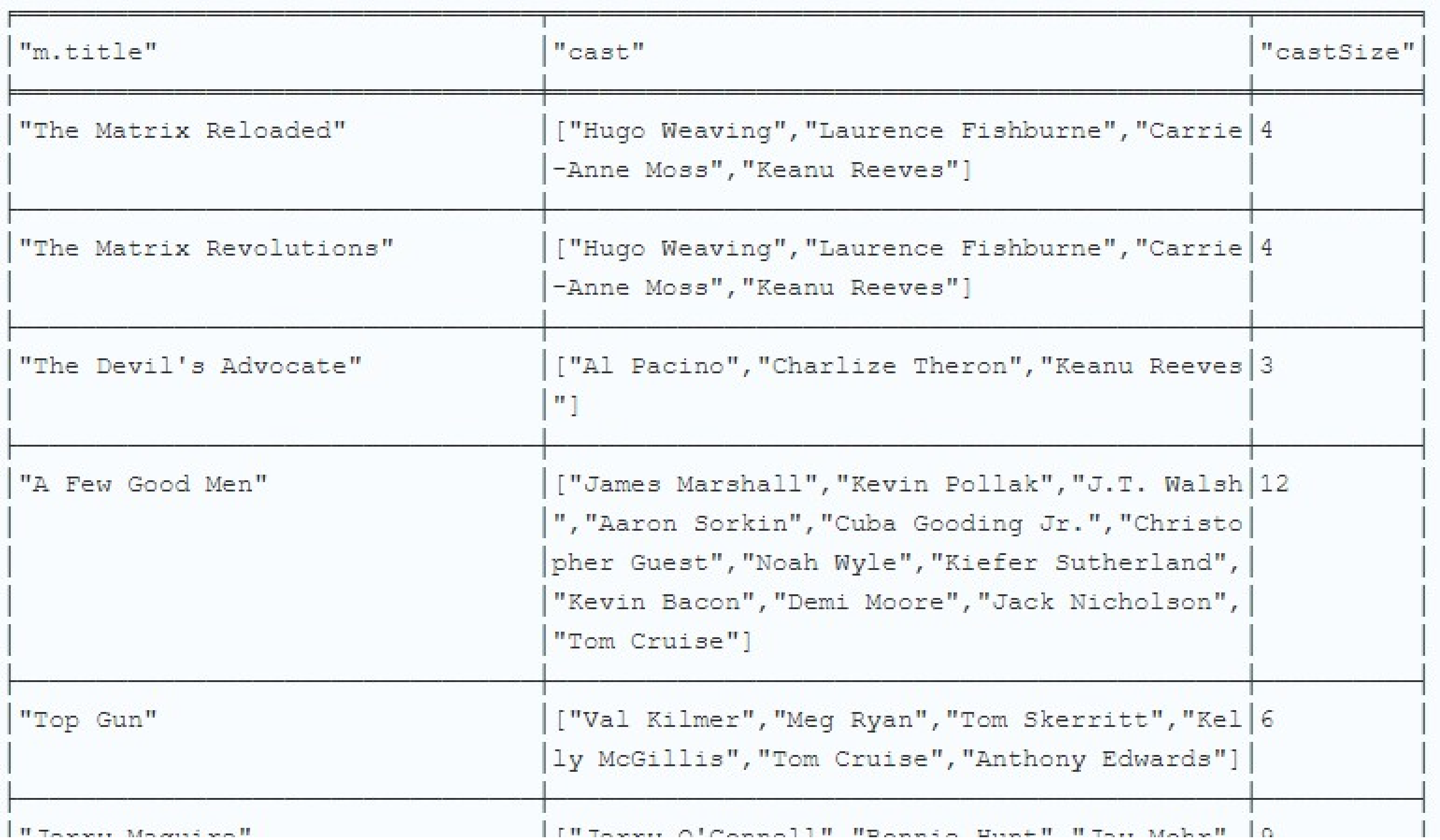


```
[
{
  "identity": 47,
  "labels": [
    "Movie"
  ],
  "properties": {
"tagline": "The rest of his life begins now.",
"title": "Jerry Maguire",
"released": 2000
  }
},
{
  "identity": 25,
  "labels": [
    "Movie"
  ],
  "properties": {
"tagline": "…",
"title": "A Few Good Men",
"released": 1992
  }
}
…
]
```

Zeichenketten in Listen

Mittwoch, 29. Dezember 2021 11:20

```
MATCH (a:Person)-[:ACTED_IN]->(m:Movie)
RETURN m.title, collect(a.name) as cast, count(*) as castSize
```

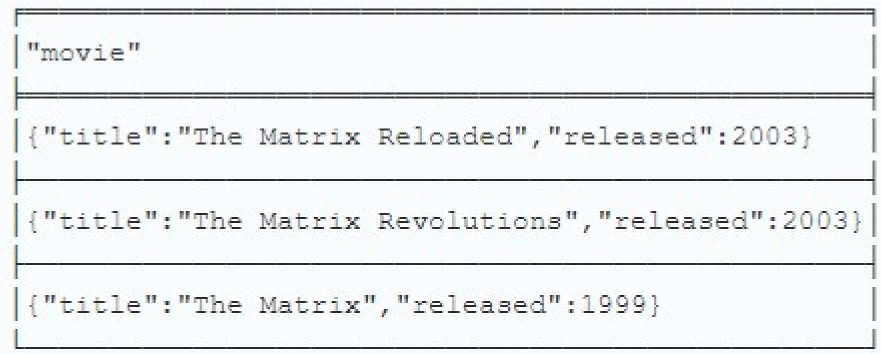


```
╒══════════════════════════════════╤═════════════════════════════════════════════╤═══════════╕
│"m.title"                         │"cast"                                       │"castSize" │
╞══════════════════════════════════╪═════════════════════════════════════════════╪═══════════╡
│"The Matrix Reloaded"             │["Hugo Weaving","Laurence Fishburne","Carrie│4          │
│                                  │-Anne Moss","Keanu Reeves"]                  │           │
├──────────────────────────────────┼─────────────────────────────────────────────┼───────────┤
│"The Matrix Revolutions"          │["Hugo Weaving","Laurence Fishburne","Carrie│4          │
│                                  │-Anne Moss","Keanu Reeves"]                  │           │
├──────────────────────────────────┼─────────────────────────────────────────────┼───────────┤
│"The Devil's Advocate"            │["Al Pacino","Charlize Theron","Keanu Reeves│3          │
│                                  │"]                                           │           │
├──────────────────────────────────┼─────────────────────────────────────────────┼───────────┤
│"A Few Good Men"                  │["James Marshall","Kevin Pollak","J.T. Walsh│12         │
│                                  │","Aaron Sorkin","Cuba Gooding Jr.","Christo│           │
│                                  │pher Guest","Noah Wyle","Kiefer Sutherland",│           │
│                                  │"Kevin Bacon","Demi Moore","Jack Nicholson",│           │
│                                  │"Tom Cruise"]                                │           │
├──────────────────────────────────┼─────────────────────────────────────────────┼───────────┤
│"Top Gun"                         │["Val Kilmer","Meg Ryan","Tom Skerritt","Kel│6          │
│                                  │ly McGillis","Tom Cruise","Anthony Edwards"]│           │
├──────────────────────────────────┼─────────────────────────────────────────────┼───────────┤
│"Jerry Maguire"                   │["Jerry O'Connell","Bonnie Hunt","Jay Mohr",│9          │
```

Projektionen

Mittwoch, 29. Dezember 2021 11:22

```
MATCH (m:Movie)
WHERE m.title CONTAINS 'Matrix'
RETURN m{.title, .released} AS movie
```



```
╒═════════════════════════════════════════════════╕
│"movie"                                          │
╞═════════════════════════════════════════════════╡
│{"title":"The Matrix Reloaded","released":2003}  │
├─────────────────────────────────────────────────┤
│{"title":"The Matrix Revolutions","released":2003}│
├─────────────────────────────────────────────────┤
│{"title":"The Matrix","released":1999}           │
└─────────────────────────────────────────────────┘
```

WITH

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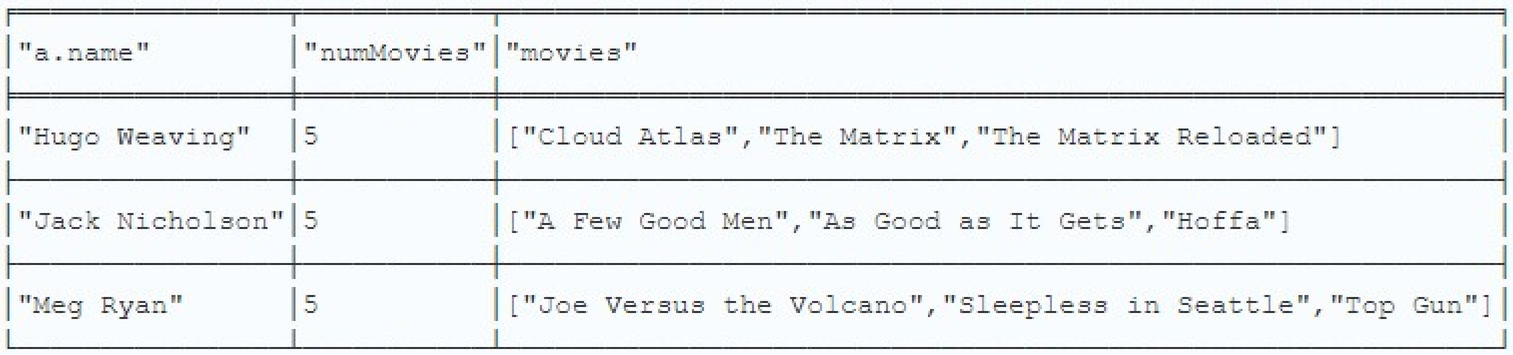
```
MATCH (a:Person)-[:ACTED_IN]->(m:Movie)
WITH a, count(a) AS numMovies, apoc.coll.sort(collect(m.title))[0..3] as movies
WHERE numMovies = 5
RETURN a.name, numMovies, movies
ORDER BY a.name
```

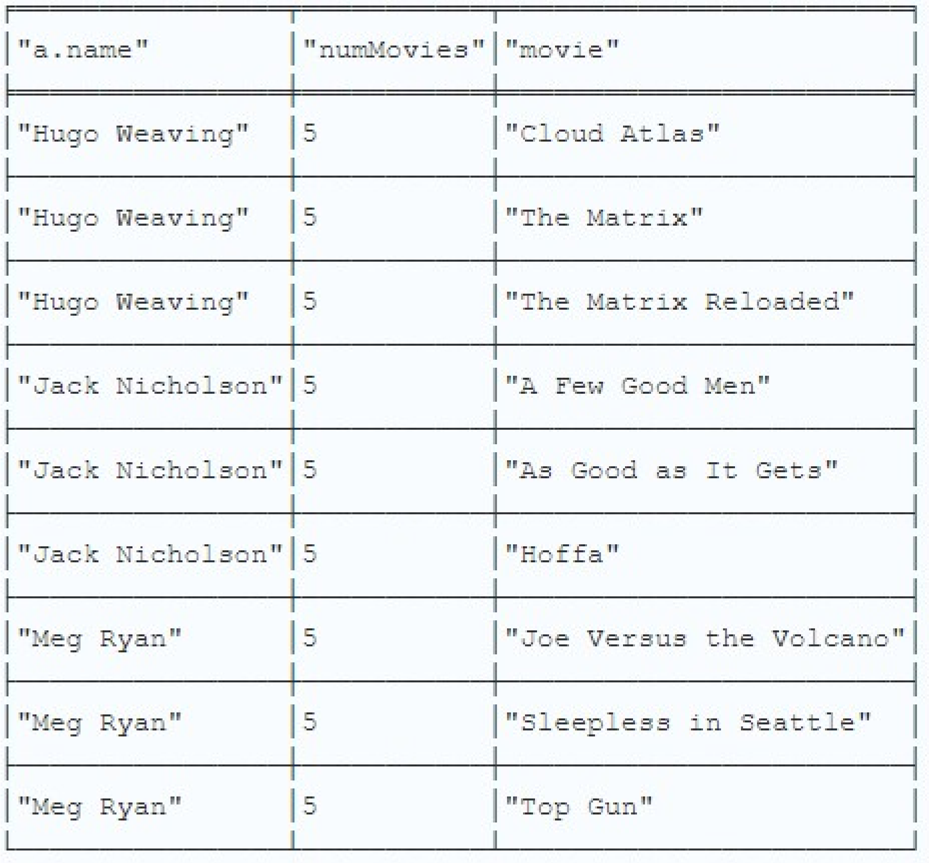


```
╒════════════════╤═══════════╤═══════════════════════════════════════════════════════════╕
│"a.name"        │"numMovies"│"movies"                                                   │
╞════════════════╪═══════════╪═══════════════════════════════════════════════════════════╡
│"Hugo Weaving"  │5          │["Cloud Atlas","The Matrix","The Matrix Reloaded"]         │
├────────────────┼───────────┼───────────────────────────────────────────────────────────┤
│"Jack Nicholson"│5          │["A Few Good Men","As Good as It Gets","Hoffa"]            │
├────────────────┼───────────┼───────────────────────────────────────────────────────────┤
│"Meg Ryan"      │5          │["Joe Versus the Volcano","Sleepless in Seattle","Top Gun"]│
└────────────────┴───────────┴───────────────────────────────────────────────────────────┘
```

UNWIND

Mittwoch, 29. Dezember 2021 11:29

```
MATCH (a:Person)-[:ACTED_IN]->(m:Movie)
WITH a, count(a) AS numMovies, apoc.coll.sort(collect(m.title))[0..3] as movies
WHERE numMovies = 5
UNWIND movies as movie
RETURN a.name, numMovies, movie
```



```
╒════════════════╤═══════════╤════════════════════════╕
│"a.name"        │"numMovies"│"movie"                 │
╞════════════════╪═══════════╪════════════════════════╡
│"Hugo Weaving"  │5          │"Cloud Atlas"           │
├────────────────┼───────────┼────────────────────────┤
│"Hugo Weaving"  │5          │"The Matrix"            │
├────────────────┼───────────┼────────────────────────┤
│"Hugo Weaving"  │5          │"The Matrix Reloaded"   │
├────────────────┼───────────┼────────────────────────┤
│"Jack Nicholson"│5          │"A Few Good Men"        │
├────────────────┼───────────┼────────────────────────┤
│"Jack Nicholson"│5          │"As Good as It Gets"    │
├────────────────┼───────────┼────────────────────────┤
│"Jack Nicholson"│5          │"Hoffa"                 │
├────────────────┼───────────┼────────────────────────┤
│"Meg Ryan"      │5          │"Joe Versus the Volcano"│
├────────────────┼───────────┼────────────────────────┤
│"Meg Ryan"      │5          │"Sleepless in Seattle"  │
├────────────────┼───────────┼────────────────────────┤
│"Meg Ryan"      │5          │"Top Gun"               │
└────────────────┴───────────┴────────────────────────┘
```

Verwaltung von Knoten

Freitag, 18. März 2022 10:32

Erzeugung von Knoten

```
CREATE (m:Movie:Action {title: 'Batman Begins'})

CREATE
(:Person {name: 'Michael Caine', born: 1933}),
(:Person {name: 'Liam Neeson', born: 1952}),
(:Person {name: 'Katie Holmes', born: 1978}),
(:Person {name: 'Benjamin Melniker', born: 1913})
```

Labels hinzufügen

```
MATCH (m:Movie)
WHERE m.title = 'Batman Begins'
SET m:Fantasy
RETURN labels(m)
```

Properties hinzufügen

```
MATCH (m:Movie)
WHERE m.title = 'Batman Begins'
SET m.released = 2005, m.lengthInMinutes = 140
RETURN m
```

Löschen von Knoten

```
MATCH (p:Person)
WHERE p.name = 'Jane Doe'
DELETE p
```

Löschen von Knoten eines Labels

```
 match (p:Person) detach delete p
```

Löschen alle Knoten

```
match (n) detach delete n
```

Verwaltung von Kanten

Freitag, 18. März 2022 10:50

Erzeugung von Kanten

```
MATCH (a:Person), (m:Movie)
WHERE
  a.name = 'Michael Caine' AND
  m.title = 'Batman Begins'
CREATE (a)-[:ACTED_IN]->(m)
```

```
MATCH (a:Person), (m:Movie), (p:Person)
WHERE a.name = 'Liam Neeson' AND
m.title = 'Batman Begins' AND
p.name = 'Benjamin Melniker'
CREATE (a)-[:ACTED_IN]->(m)<-[:PRODUCED]-(p)
```

Kanten mit Properties

```
MATCH (a:Person), (m:Movie)
WHERE a.name = 'Katie Holmes' AND m.title = 'Batman Begins'
CREATE (a)-[rel:ACTED_IN {roles: ['Rachel','Rachel Dawes']}]->(m)
```

Knoten und Kanten zusammen

```
MATCH (m:Movie)
WHERE m.title = 'Batman Begins'
CREATE (a:Person)-[:ACTED_IN]->(m)
SET a.name = 'Gary Oldman', a.born=1958
```

Löschen von Kanten

```
MATCH (a:Person)-[rel:WROTE | DIRECTED]->(m:Movie)
WHERE a.name = 'Katie Holmes' AND m.title = 'Batman Begins'
DELETE rel
```