Neo4j I

HIGHER DIPLOMA IN DATA ANALYTICS

Why NoSQL databases?

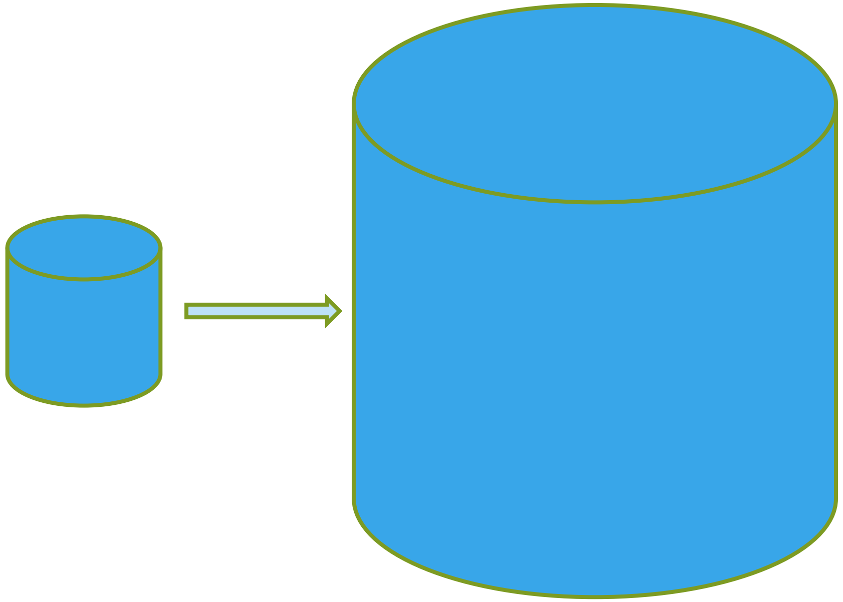
Scalability

Scale Up

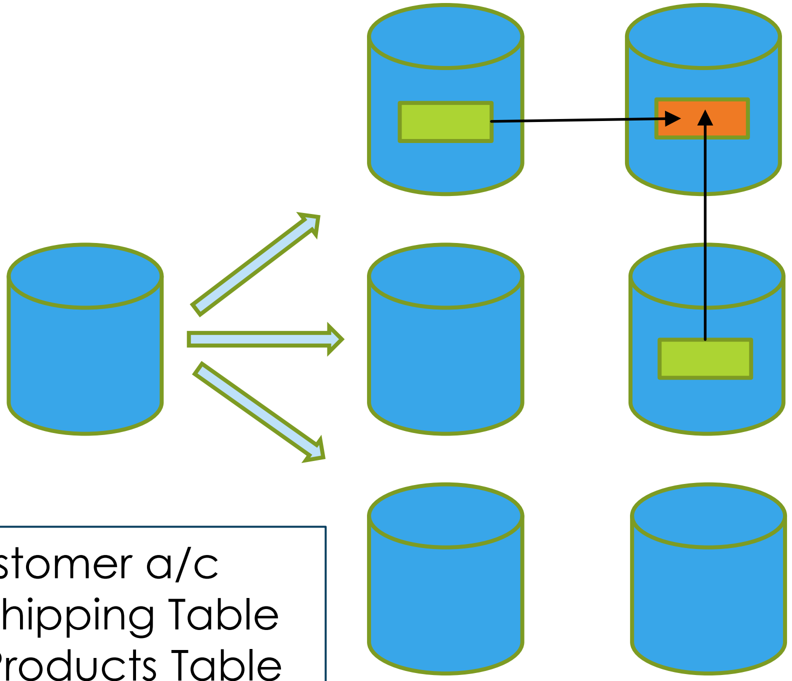
Scale Out

Scalability

- Scale Up/Vertically



- Scale Out/Horizontally



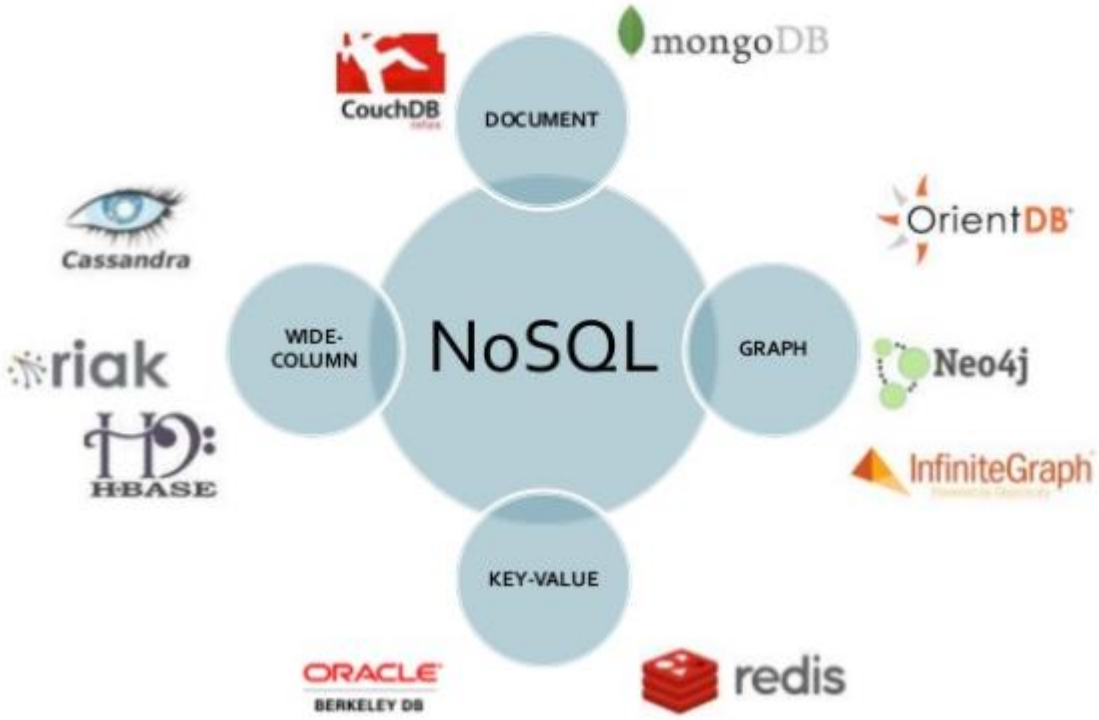
- Debit Customer a/c
- Update Shipping Table
- Update Products Table
- Credit Store a/c

Unstructured Data

- CustomerID INTEGER
- Name VARCHAR(20)
- Phone VARCHAR(20)
- Address VARCHAR(50)
- Email VARCHAR(50)
- Twitter VARCHAR(50)

CustomerID*	Name	Phone	Address	Email	Twitter
100	John	086 3304896	Tuam, Co. Galway	John@gmail.com	@John123
101	Alan	NULL	Athenry, Co. Galway	NULL	NULL
102	Mary	091 5688874	Galway, Co. Galway	Mary@yahoo.com	NULL
103	Tom	090 6458959	Athlone, Co. Westmeath	NULL	NULL
104	Alice	094 1245763	Castlebar, Co. Mayo	NULL	@AliceC1965

NoSQL Database Types



JSON

- JSON – JavaScript Object Notation
- Lightweight data-interchange format
- Machine/Human readable
- Language independent
- JSON Structure:
  - Name/Value pairs
  - Ordered Lists

JSON Datatypes

Number

```
{
    "id" : 1
}
```

```
{
    "id" : 3.14
}
```

String

```
{
    "id" : 1,
    "fname" : "John"
}
```

Boolean

```
{
    "reg" : "09-G-13",
    "hybrid" : false
}
```

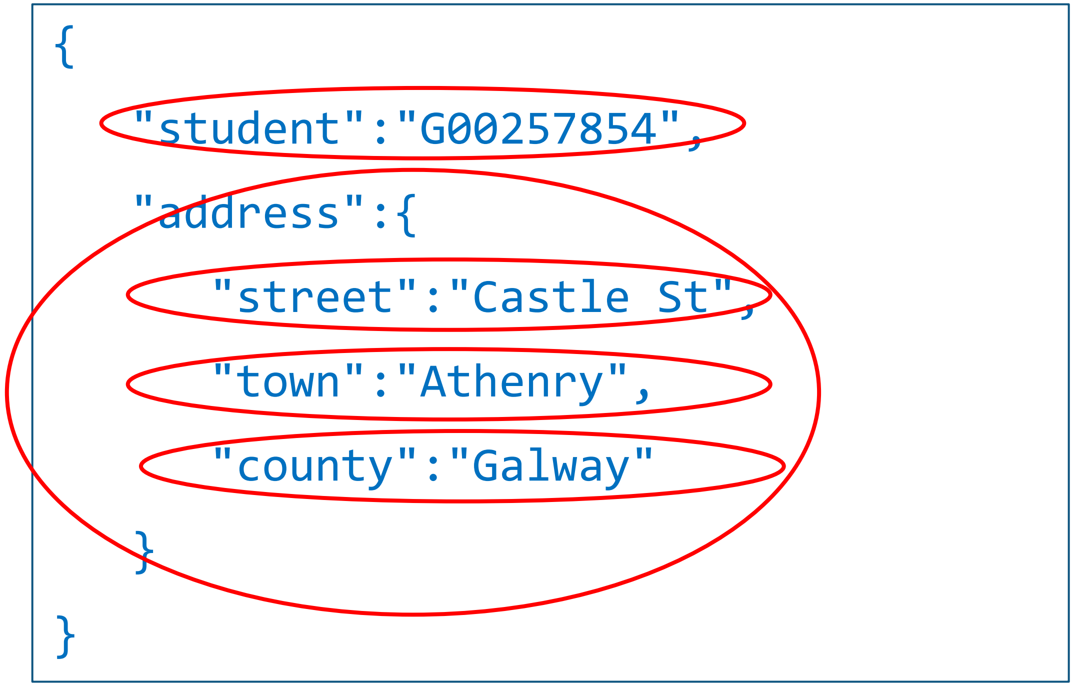
JSON Datatypes

Array

```
{
   "student" : "G00257854",
   "subjects" : ["Databases", "Java", "Mobile Apps"]
}
```

JSON Datatypes

Objects

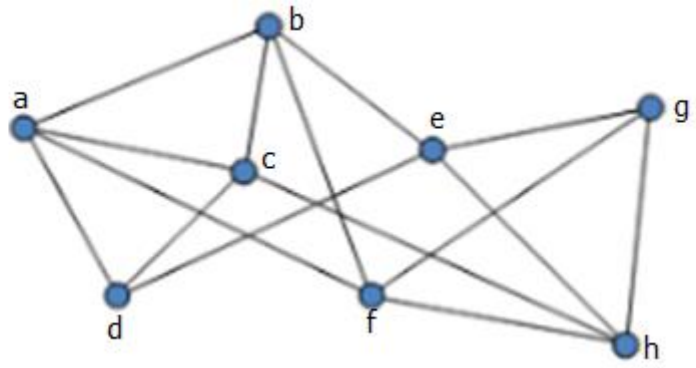


```
{
   "student":"G00257854",
   "address":{
      "street":"Castle St",
      "town":"Athenry",
      "county":"Galway"
   }
}
```

Graphs

- In Mathematical terms, a Graph is a collection of elements - typically called Nodes (also called Vertices or Points) - that are joined together by Edges.
- Each Node represents some piece of information in the Graph.
- Each Edge represents some connection between two Nodes.
- Graphs are a common method to visually illustrate relationships in the data.

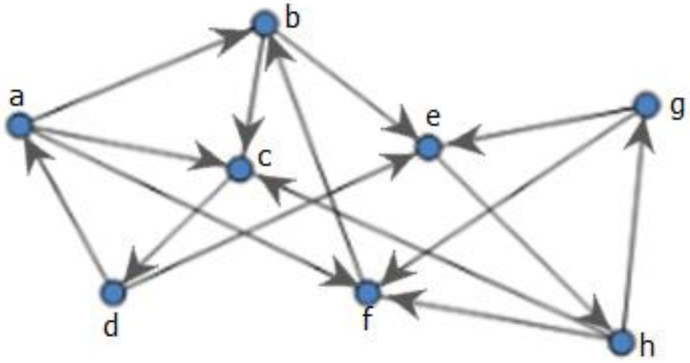
Graphs



V = {a, b, c, d, e, f, g, h}

E = {**ab**, **ba**, ac, ca, ad, da, af, fa,
bc, cb, be, eb, bf, fb, cd, dc,
ch, hc, de, ed, eg, ge, eh, he,
fg, gf, fh, hf, gh, hg}

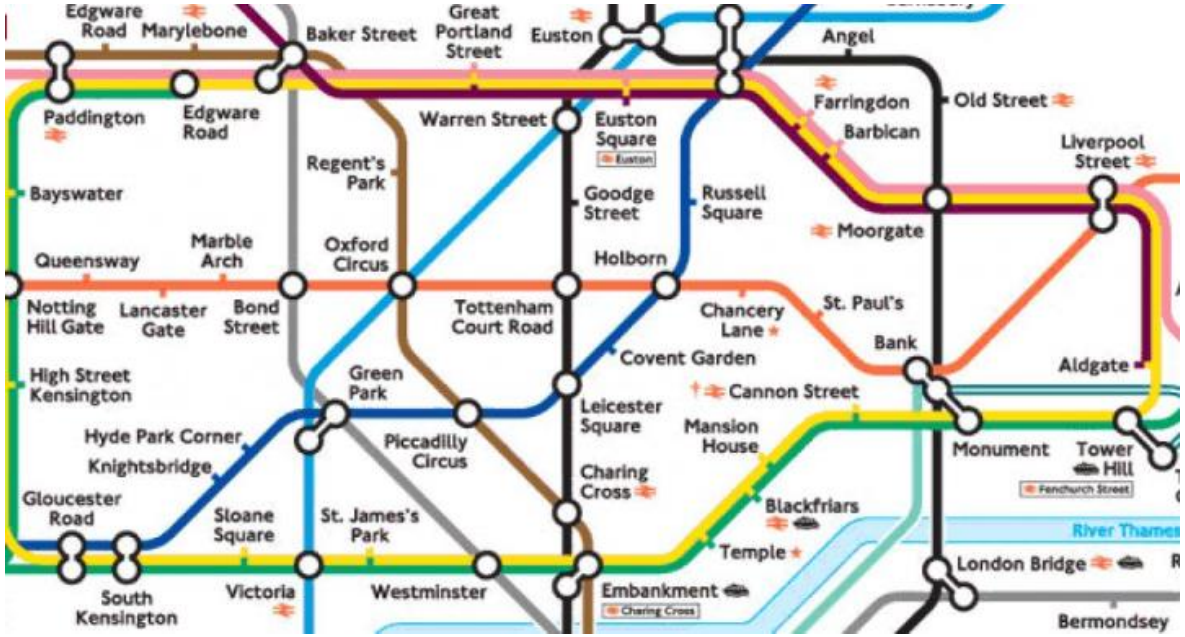
Graphs

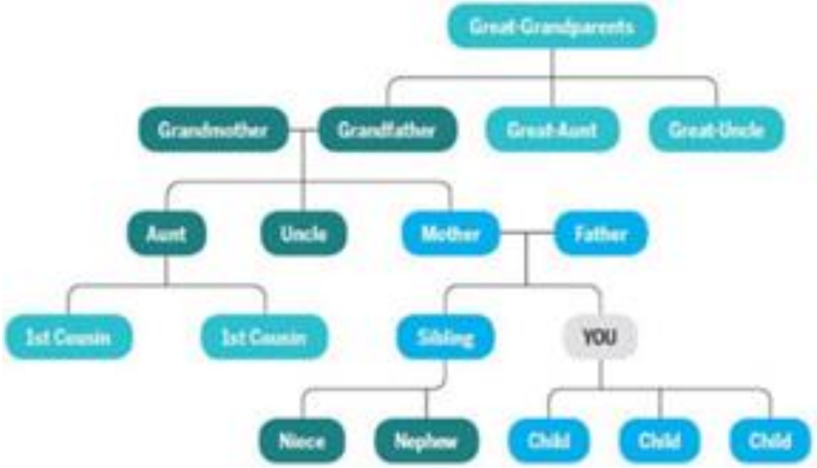


V = {a, b, c, d, e, f, g, h}

E = {ab, ac, af, bc, be, cd, da,
de, eh, fb, ge, gf, hc, hf, hg}

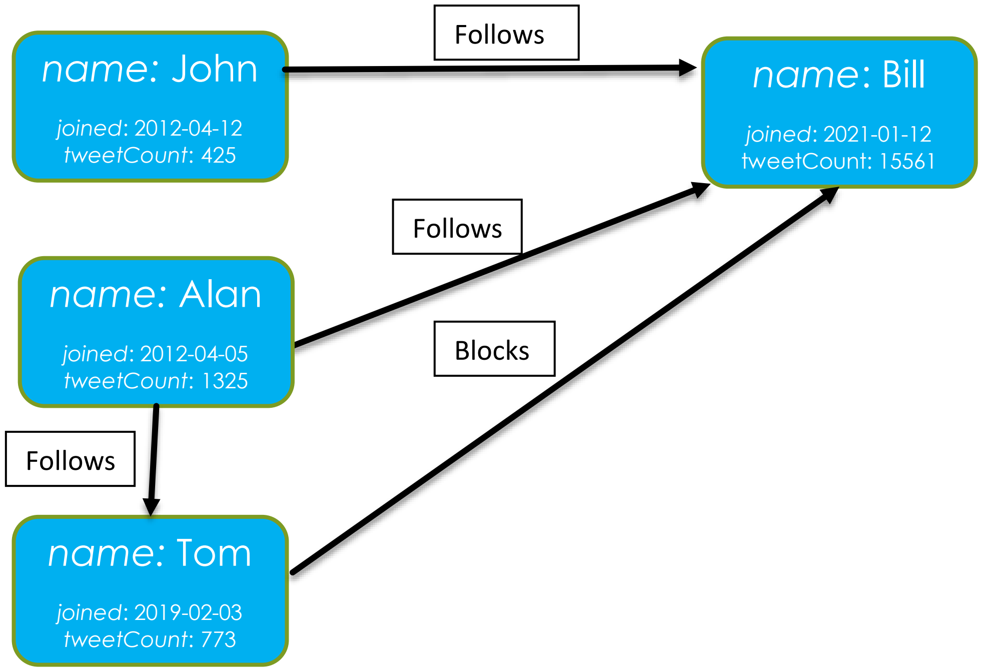
Graphs


Edgware Road
Marylebone
Baker Street
Great Portland Street
Euston
Angel
Paddington
Edgware Road
Warren Street
Euston Square
Euston
Farringdon
Barbican
Old Street
Liverpool Street
Regent's Park
Goodge Street
Russell Square
Moorgate
Bayswater
Queensway
Marble Arch
Oxford Circus
Holborn
Notting Hill Gate
Lancaster Gate
Bond Street
Tottenham Court Road
Chancery Lane
St. Paul's
Bank
High Street Kensington
Green Park
Covent Garden
Aldgate
Cannon Street
Leicester Square
Hyde Park Corner
Knightsbridge
Piccadilly Circus
Mansion House
Monument
Tower Hill
Fenchurch Street
Charing Cross
Gloucester Road
Sloane Square
St. James's Park
Blackfriars
River Thames
Temple
South Kensington
Victoria
Westminster
Embankment
Charing Cross
London Bridge
Bermondsey


Great-Grandparents
Grandmother
Grandfather
Great-Aunt
Great-Uncle
Aunt
Uncle
Mother
Father
1st Cousin
1st Cousin
Sibling
YOU
Niece
Nephew
Child
Child
Child

Why Graph Databases?

- Intuitive

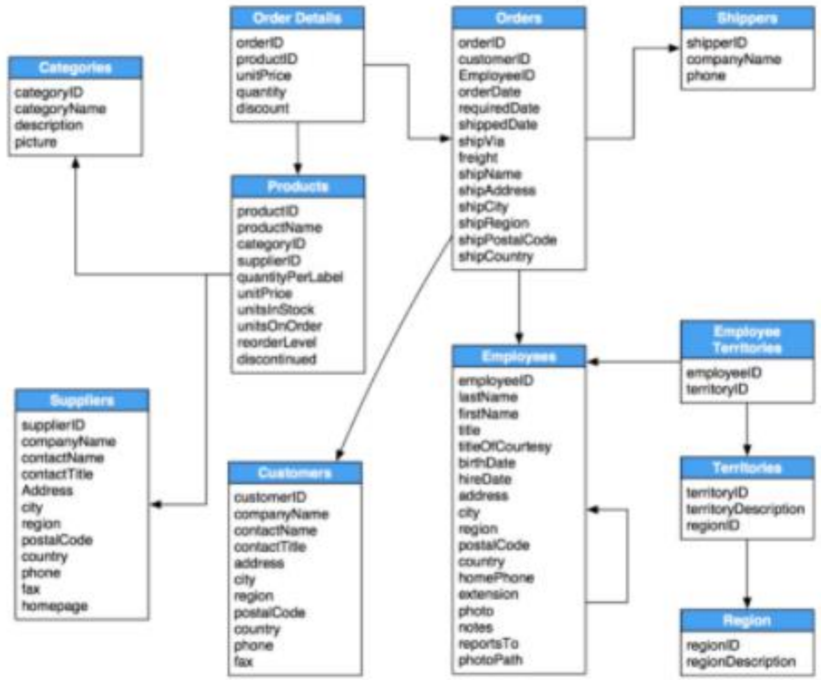


User			
UID	**name**	**joined**	**Tweet count**
100	Tom	2019-02-03	773
101	Alan	2012-04-05	1325
102	John	2012-04-12	425
103	Bill	2021-01-12	15561

Relationship	
RID	**name**
R1	Follows
R2	Blocks

User Relationship Table		
User1 ID	**User 2 ID**	**Relationship ID**
100	103	R2
101	103	R1
101	100	R1
102	103	R1

Why Graph Databases?



Categories
categoryID
categoryName
description
picture

Order Details
orderID
productID
unitPrice
quantity
discount

Products
productID
productName
categoryID
supplierID
quantityPerLabel
unitPrice
unitsInStock
unitsOnOrder
reorderLevel
discontinued

Suppliers
supplierID
companyName
contactName
contactTitle
Address
city
region
postalCode
country
phone
fax
homepage

Customers
customerID
companyName
contactName
contactTitle
address
city
region
postalCode
country
phone
fax

Orders
orderID
customerID
EmployeeID
orderDate
requiredDate
shippedDate
shipVia
freight
shipName
shipAddress
shipCity
shipRegion
shipPostalCode
shipCountry

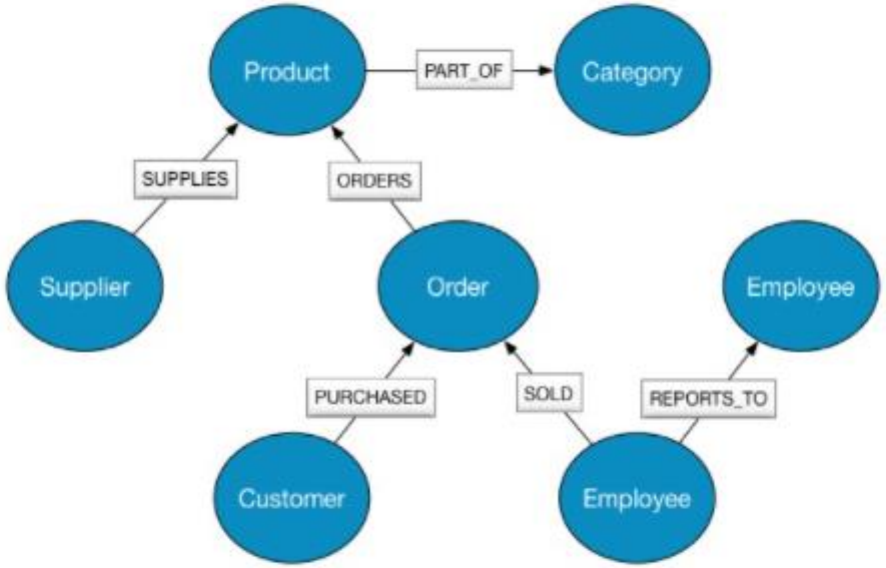
Shippers
shipperID
companyName
phone

Employees
employeeID
lastName
firstName
title
titleOfCourtesy
birthDate
hireDate
address
city
region
postalCode
country
homePhone
extension
photo
notes
reportsTo
photoPath

Employee Territories
employeeID
territoryID

Territories
territoryID
territoryDescription
regionID

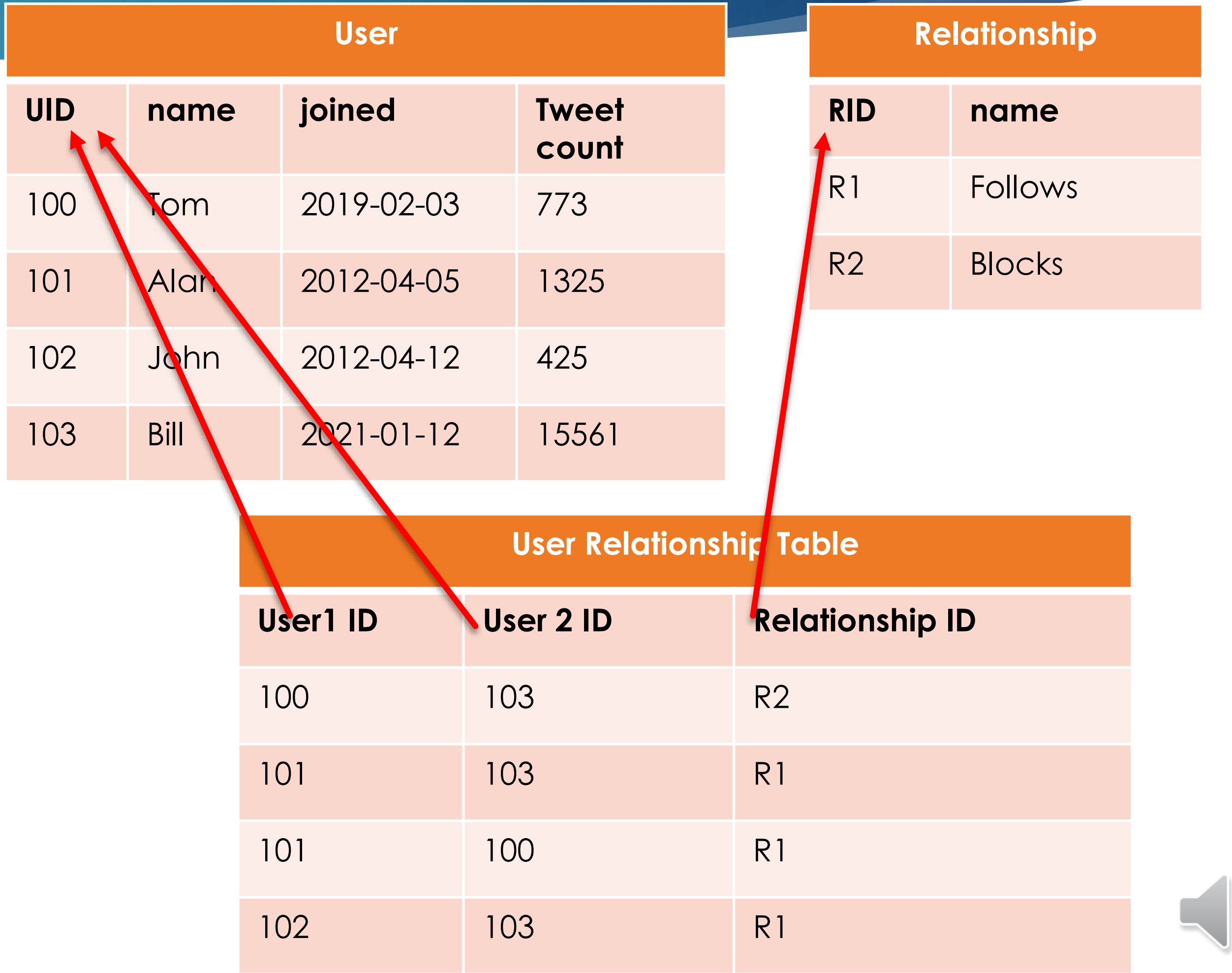
Region
regionID
regionDescription



Product
PART_OF
Category
SUPPLIES
ORDERS
Supplier
Order
Employee
PURCHASED
SOLD
REPORTS_TO
Customer
Employee

Why Graph Databases?

- Relationships are First-Class Citizens
  - A First-Class citizen is an entity that has an identity independent of any other item.
  - The identity allows the item to persist when its attributes change.
  - The identity allows other items to claim relationships with the item.
  - In a relational database First-Class citizens are entities or "things", but not the relationships between them.



User			
UID	name	joined	Tweet count
100	Tom	2019-02-03	773
101	Alan	2012-04-05	1325
102	John	2012-04-12	425
103	Bill	2021-01-12	15561

Relationship	
RID	name
R1	Follows
R2	Blocks

User Relationship Table		
User1 ID	User 2 ID	Relationship ID
100	103	R2
101	103	R1
101	100	R1
102	103	R1

Why Graph Databases?

- Unstructured Data

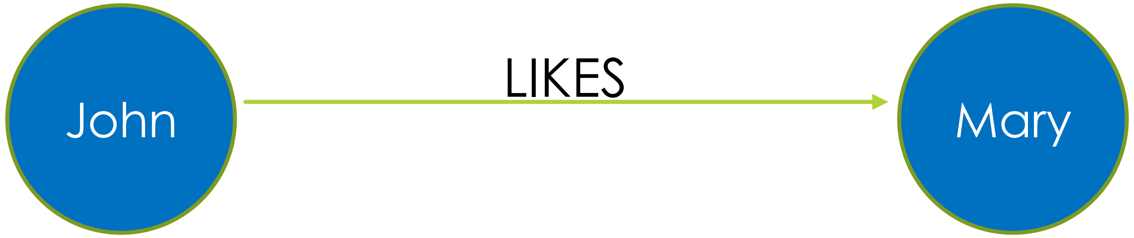
		Customer		
CID	**Name**	**Address**	**email**	**Messenger ID**
C001	John Smith	1 College Road, Galway	john@gmail.com	NULL
C002	Mary Flynn	16 The Avenue, Tuam	NULL	NULL
C003	Bill Murphy	Church Road, Mallow, Cork	bm1@gmail.com	billmurphy173

Neo4j

- Neo4j is a popular Graph Database.
  - Flexible Schema (Schemaless).
  - ACID.
  - Cypher Query Language.
  - Integration with several languages.

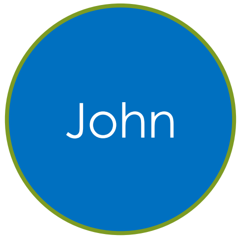
Neo4j

- Graphs have:
  - Nodes (Vertices)
  - Relationships (Edges)



Neoj4 - Node

- A *node* is the basic entity of the graph, with the unique attribute of being able to exist in and of itself.
- A node may be assigned a set of unique labels.
- A node may have properties.
- A node may have zero or more outgoing relationships.
- A node may have zero or more incoming relationships.

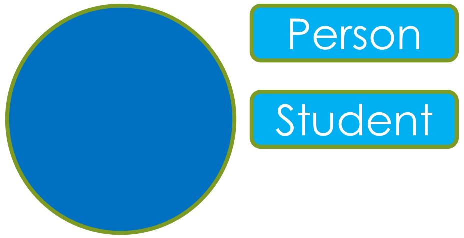


John

Neoj4 - Label

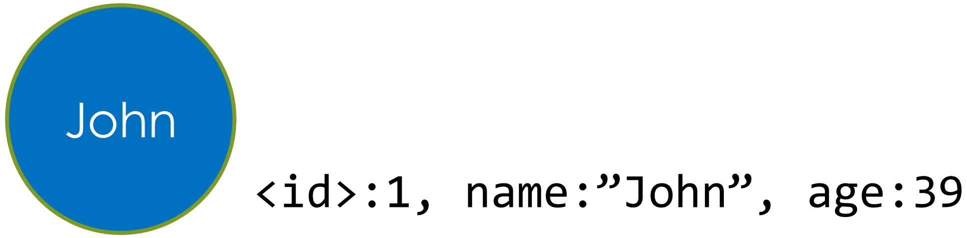
- Labels are used to shape the domain by grouping nodes into sets where all nodes that have a certain label belongs to the same set.

- A node can have zero or many labels.



Neo4j - Property

- Properties are name-value pairs that are used to add qualities to nodes.



John

```
<id>:1, name:”John”, age:39
```

Cypher

- Cypher is a declarative graph query language that allows for expressive and efficient querying and updating of the graph store.
- Focuses on *what* to retrieve from a graph, not *how* to retrieve it.
- Made up of *clauses*.

Cypher - CREATE

- `CREATE()` – Creates a Node
- `CREATE(:Person)` – Creates a Node with the label Person
- `CREATE(:Person{name:"John"})` – Creates a Node with the label Person and a property key called name and a property value of “John”.

Cypher - MATCH

- `MATCH(n) RETURN n` – Match all nodes in the database (and return them).

- `MATCH(p:Person) RETURN(p)` – Match all nodes in the database with the label Person.

- `MATCH(p:Person{name:"John"}) RETURN(p)` – Match all nodes in the database with the label Person and who have the following property:
  - key = name, value="John".

Cypher - WHERE

- WHERE adds constraints to the patterns in a MATCH.

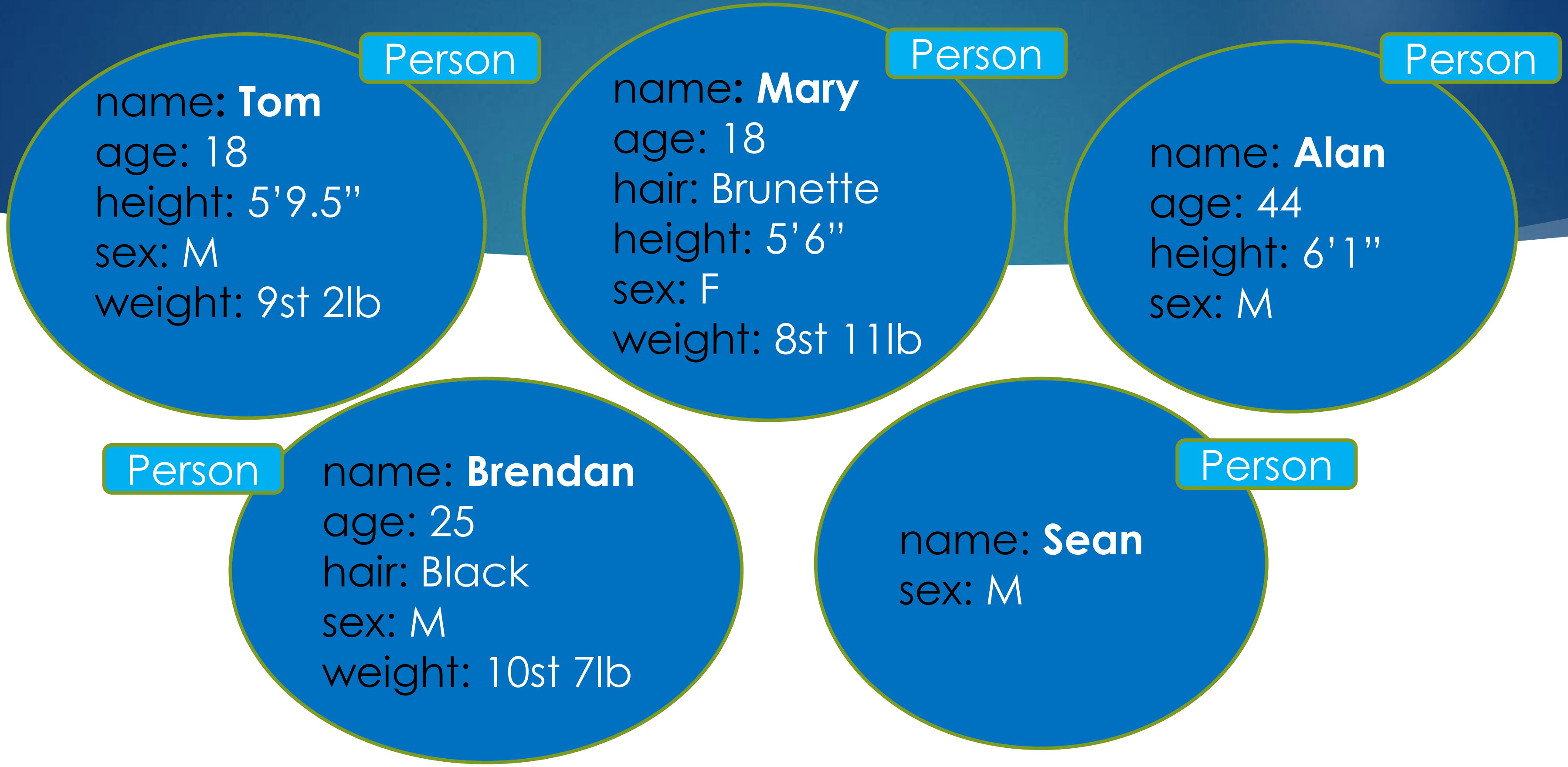
-
  ```
  MATCH(p:Person{name:"John"}) RETURN(p)
  ```

-
  ```
  MATCH(p:Person)
   WHERE p.name="John"
   RETURN p
  ```

```
MATCH(p:Person)
WHERE p.name="John"
OR p.name="Tom"
RETURN p
```

Cypher - Property Existence Checking

- Graph databases are good for storing less structured data.
- Only need to add a property to a node if necessary.
- May only be interested in nodes with/without specific properties.



Person

name: **Tom**
age: 18
height: 5’9.5”
sex: M
weight: 9st 2lb

Person

name: **Mary**
age: 18
hair: Brunette
height: 5’6”
sex: F
weight: 8st 11lb

Person

name: **Alan**
age: 44
height: 6’1”
sex: M

Person

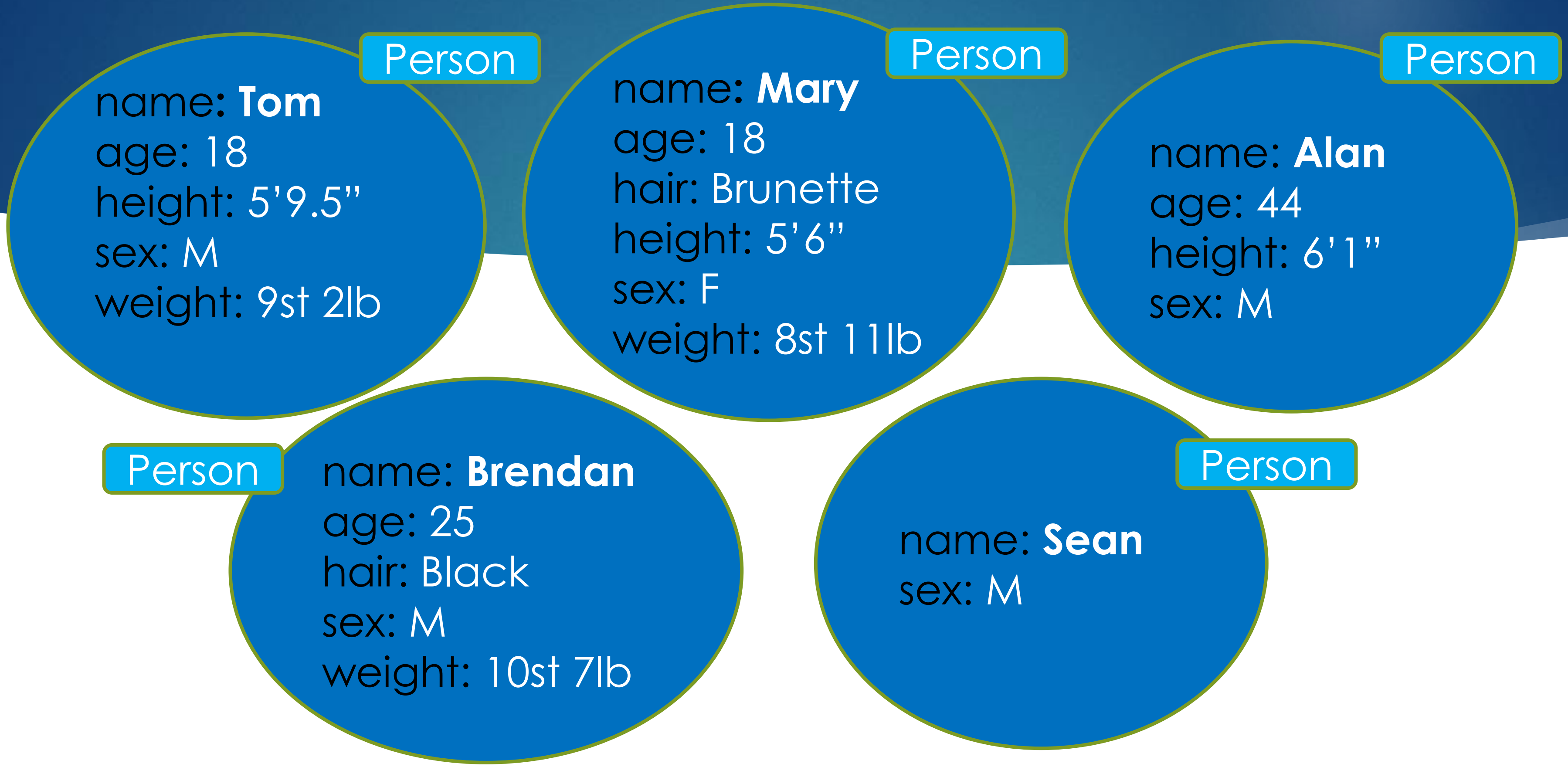
name: **Brendan**
age: 25
hair: Black
sex: M
weight: 10st 7lb

Person

name: **Sean**
sex: M

- Find all People who have a weight property:

```
MATCH(p:Person) WHERE p.weight IS NOT NULL RETURN p
```



Person

name: **Tom**
age: 18
height: 5’9.5”
sex: M
weight: 9st 2lb

Person

name: **Mary**
age: 18
hair: Brunette
height: 5’6”
sex: F
weight: 8st 11lb

Person

name: **Alan**
age: 44
height: 6’1”
sex: M

Person

name: **Brendan**
age: 25
hair: Black
sex: M
weight: 10st 7lb

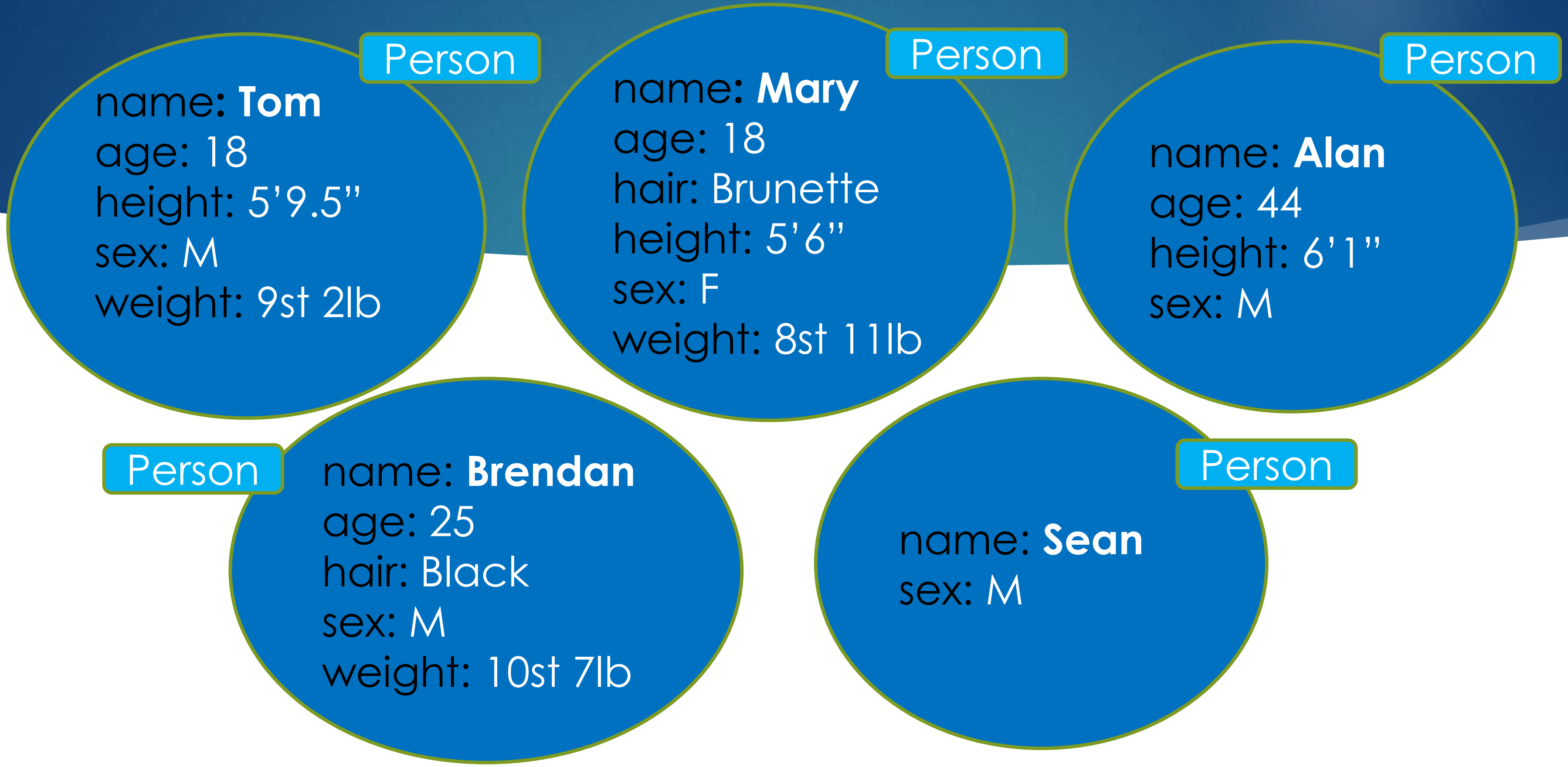
Person

name: **Sean**
sex: M

- Find all Males who have a weight property:

```
MATCH(p:Person{sex:"M"})
WHERE p.weight IS NOT NULL
RETURN p
```

```
MATCH(p:Person)
WHERE p.weight IS NOT NULL
AND p.sex="M"
RETURN p
```



Person
name: **Tom**
age: 18
height: 5'9.5"
sex: M
weight: 9st 2lb

Person
name: **Mary**
age: 18
hair: Brunette
height: 5'6"
sex: F
weight: 8st 11lb

Person
name: **Alan**
age: 44
height: 6'1"
sex: M

Person
name: **Brendan**
age: 25
hair: Black
sex: M
weight: 10st 7lb

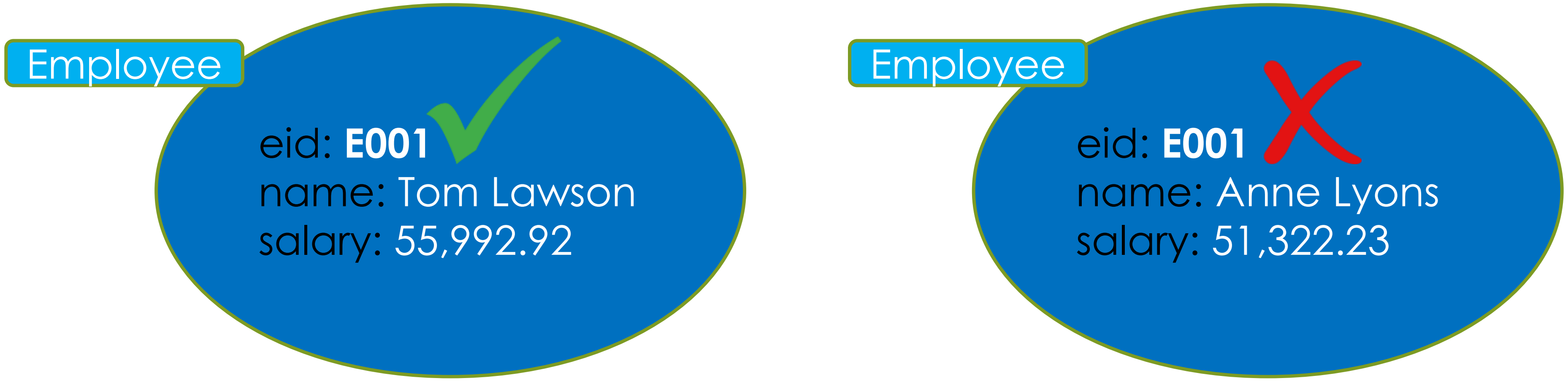
Person
name: **Sean**
sex: M

- Find all Brendan's properties:

```
MATCH (n:Person{name:"Brendan"}) RETURN keys(n)
["hair", "name", "weight", "age", "sex"]
```

Constraints

- A constraint ensures data integrity.
- `CREATE CONSTRAINT eid_unique ON (e:Employee) ASSERT e.eid IS UNIQUE`



Employee

eid: **E001** ✓
name: Tom Lawson
salary: 55,992.92

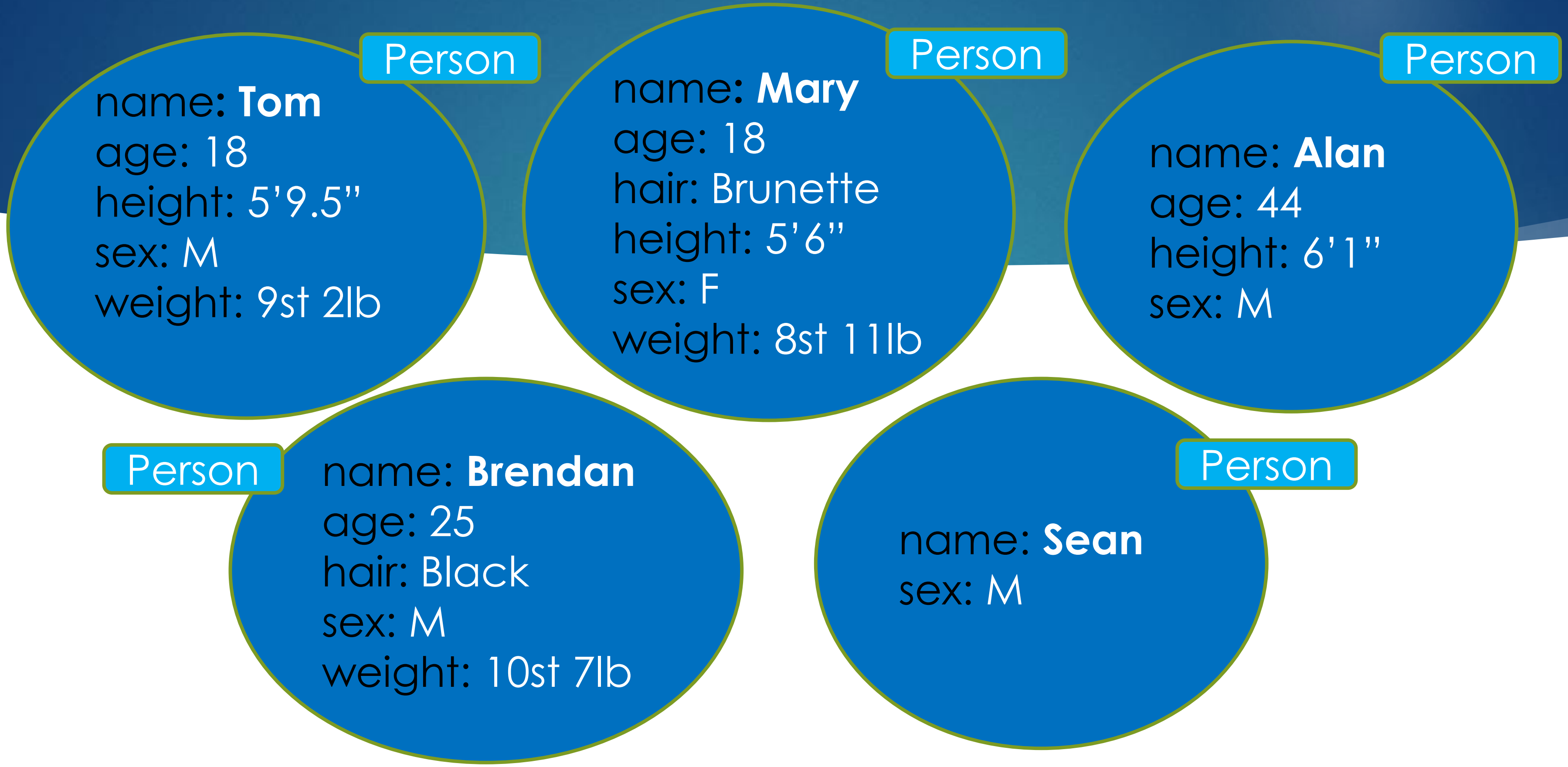
Employee

eid: **E001** ✗
name: Anne Lyons
salary: 51,322.23

Cypher – Aggregating Functions

- Aggregating functions take a set of values and calculate an aggregated value over them.

  - avg()
  - max()
  - min()
  - sum()



Person

name: **Tom**
age: 18
height: 5’9.5”
sex: M
weight: 9st 2lb

Person

name: **Mary**
age: 18
hair: Brunette
height: 5’6”
sex: F
weight: 8st 11lb

Person

name: **Alan**
age: 44
height: 6’1”
sex: M

Person

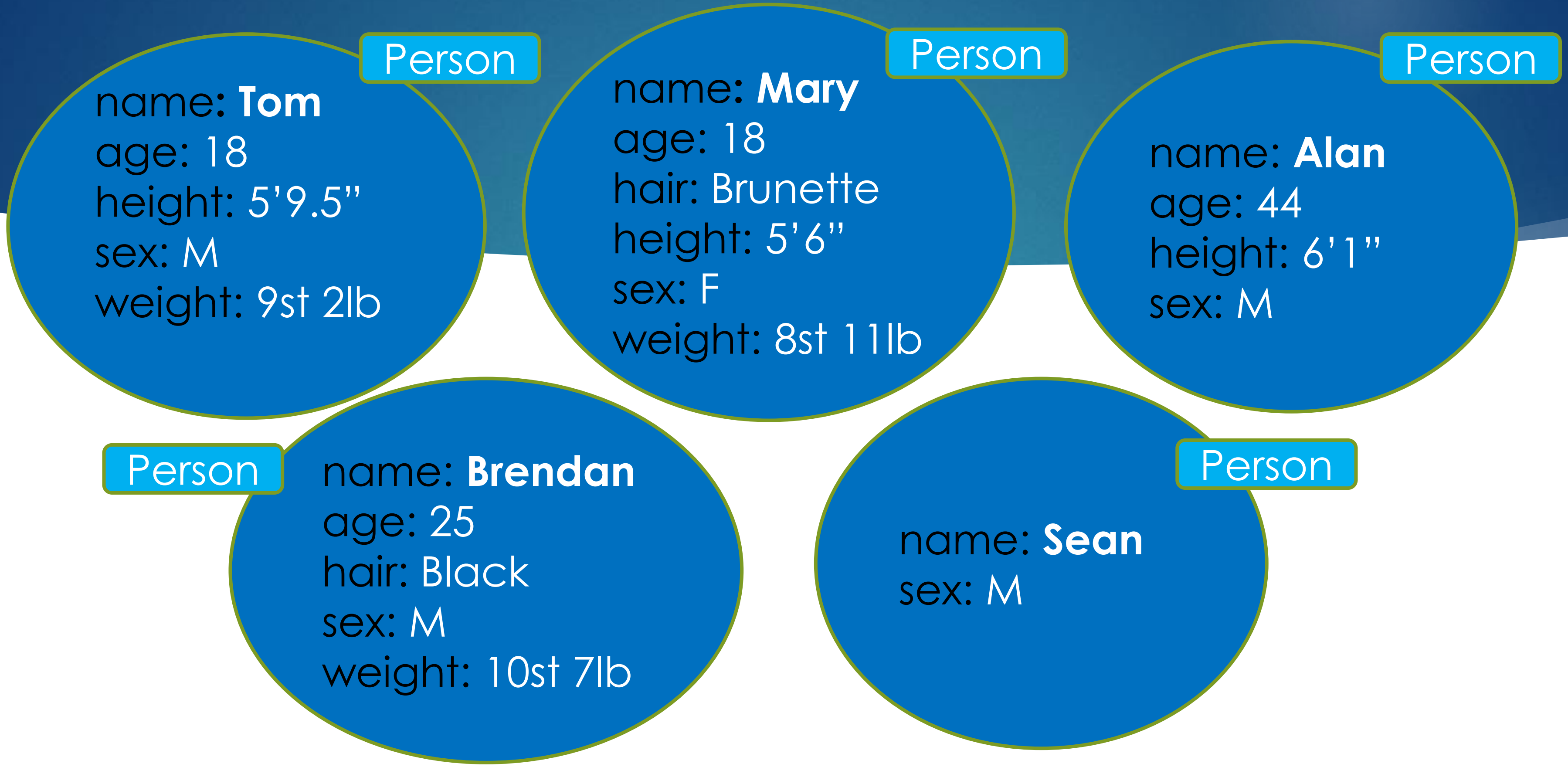
name: **Brendan**
age: 25
hair: Black
sex: M
weight: 10st 7lb

Person

name: **Sean**
sex: M

- Find the average age of Males:

```
MATCH(n{sex:"M"}) RETURN avg(n.age)
29.0
```



Person

name: **Tom**
age: 18
height: 5’9.5”
sex: M
weight: 9st 2lb

Person

name: **Mary**
age: 18
hair: Brunette
height: 5’6”
sex: F
weight: 8st 11lb

Person

name: **Alan**
age: 44
height: 6’1”
sex: M

Person

name: **Brendan**
age: 25
hair: Black
sex: M
weight: 10st 7lb

Person

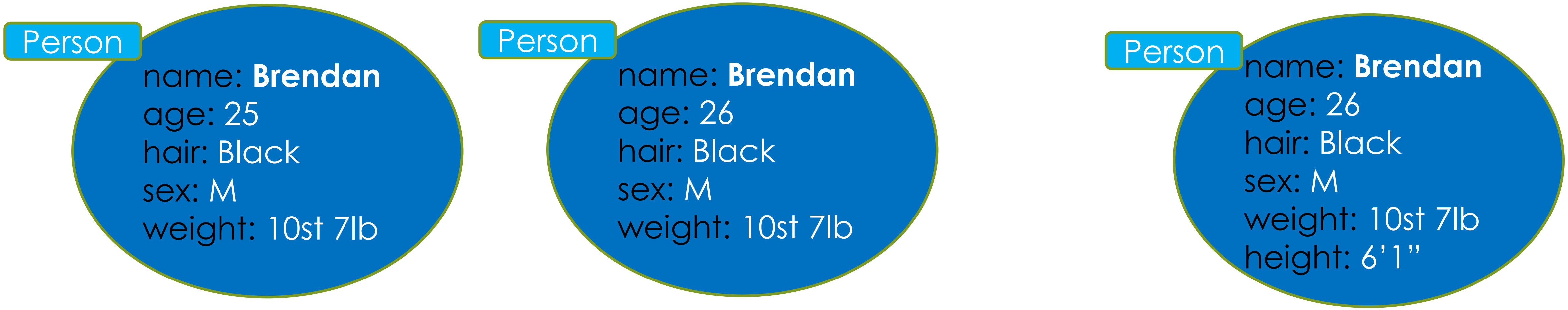
name: **Sean**
sex: M

- Find the average age of Males and Females:

```
MATCH(n) RETURN n.sex, avg(n.age)
"M"    29.0
"F"    18.0
```

Cypher - SET

- The SET clause is used to update labels on nodes and properties on nodes.



Person
name: **Brendan**
age: 25
hair: Black
sex: M
weight: 10st 7lb

Person
name: **Brendan**
age: 26
hair: Black
sex: M
weight: 10st 7lb

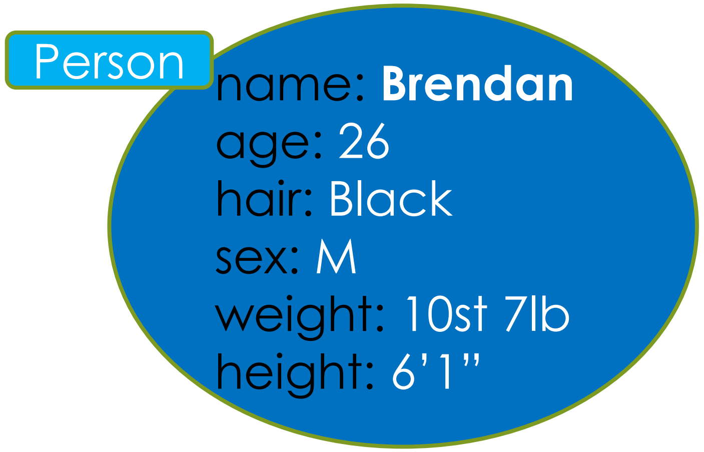
Person
name: **Brendan**
age: 26
hair: Black
sex: M
weight: 10st 7lb
height: 6’1”

```
MATCH(n{name:"Brendan"})
SET n.age = n.age+1
RETURN n
```

```
MATCH(n{name:"Brendan"})
SET n.height = "6'1\""
RETURN n
```

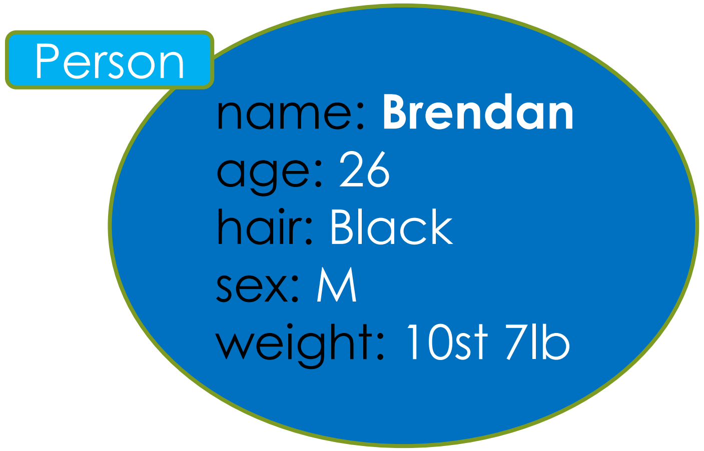
Cypher - REMOVE

- The REMOVE clause is used to remove labels from nodes and properties from nodes.



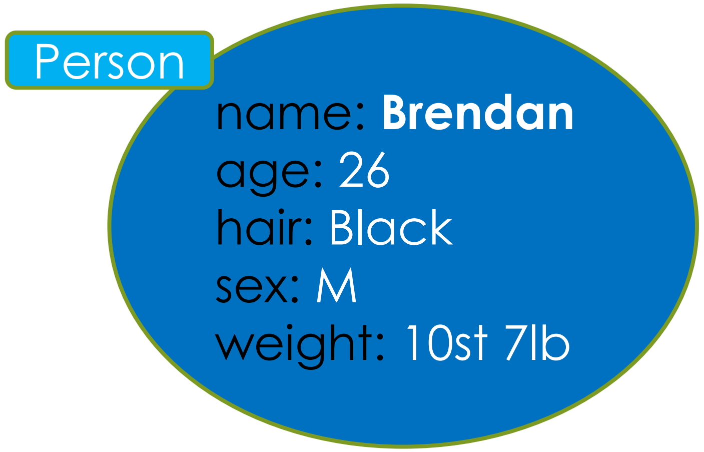
Person

name: **Brendan**
age: 26
hair: Black
sex: M
weight: 10st 7lb
height: 6'1"



Person

name: **Brendan**
age: 26
hair: Black
sex: M
weight: 10st 7lb



Person

name: **Brendan**
age: 26
hair: Black
sex: M
weight: 10st 7lb

```
match(n{name:"Brendan"})
remove n.height
return n
```

```
match(n{name:"Brendan"})
remove n.height
return n
```

Cypher - DELETE

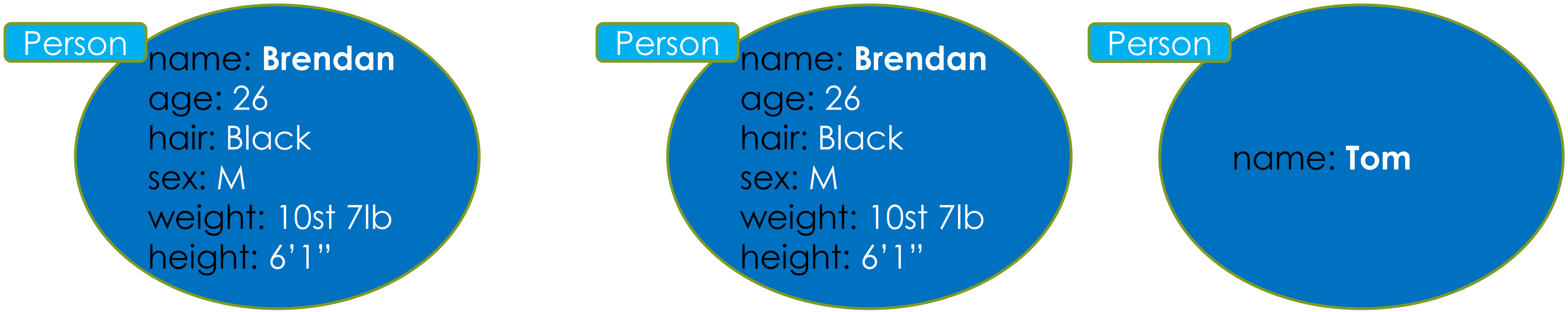
- The DELETE clause is used to delete nodes, relationships or paths.

```
MATCH(p:Person) DELETE p
```

```
MATCH(p:Person) WHERE p.weight IS NULL DELETE p
```

Cypher - MERGE

- The MERGE clause ensures that a pattern exists in the graph.
- Either the pattern already exists, or it needs to be created.



Person

name: **Brendan**
age: 26
hair: Black
sex: M
weight: 10st 7lb
height: 6’1”

Person

name: **Brendan**
age: 26
hair: Black
sex: M
weight: 10st 7lb
height: 6’1”

Person

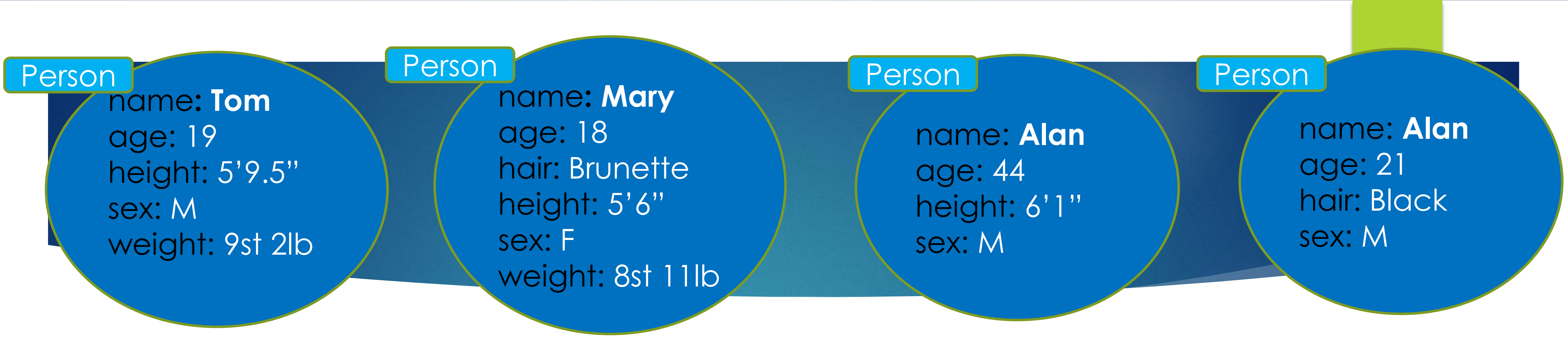
name: **Tom**

```
MERGE(p:Person{name:"Brendan"})
RETURN p
```

```
MERGE(p:Person{name:"Tom"})
RETURN p
```

WITH

- The WITH clause allows query parts to be chained together, piping the results from one part of the query to the next.



Person

name: **Tom**
age: 19
height: 5’9.5”
sex: M
weight: 9st 2lb

Person

name: **Mary**
age: 18
hair: Brunette
height: 5’6”
sex: F
weight: 8st 11lb

Person

name: **Alan**
age: 44
height: 6’1”
sex: M

Person

name: **Alan**
age: 21
hair: Black
sex: M

```
MATCH(n:Person) RETURN avg(n.age)
```

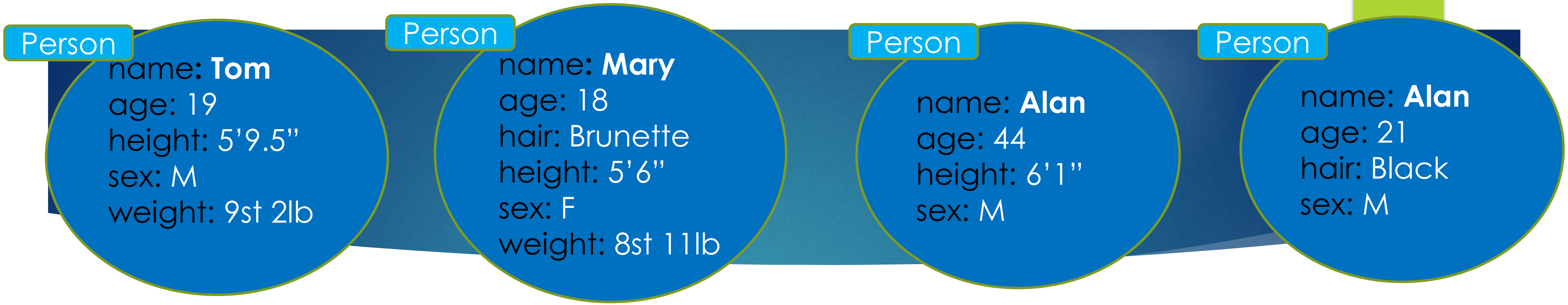
25.5

```
MATCH(n:Person) RETURN n.name AS Name, avg(n.age) AS Avg
```

Name	Avg
Tom	19.0
Mary	18.0
Alan	32.5

```
MATCH(n:Person) WITH avg(n.age) as averageAGE
MATCH(n1:Person) WHERE n1.age < averageAGE
RETURN n1.name AS Name
```

Name
Tom
Mary
Alan



Person

name: **Tom**
age: 19
height: 5’9.5”
sex: M
weight: 9st 2lb

Person

name: **Mary**
age: 18
hair: Brunette
height: 5’6”
sex: F
weight: 8st 11lb

Person

name: **Alan**
age: 44
height: 6’1”
sex: M

Person

name: **Alan**
age: 21
hair: Black
sex: M

- Return the number of Males (as *Num_Younger*) who are less than the average Male age.

```
MATCH(p:Person{sex:"M"}) WITH avg(p.age) AS avgAge
MATCH(p1:Person{sex:"M"}) WHERE p1.age < avgAge
RETURN count(p1) as Num_Younger
```

Num_Younger
2