Aim: Semantic Web using Apache TinkerPop.

Lab Objective:

To understand the concept of the Semantic Web by modeling data as a graph using Apache TinkerPop. To create vertices and edges and perform basic graph queries using Gremlin to explore meaningful relationships between data.

Theory:

Q1. What is Semantic Web?

The Semantic Web is an extension of the World Wide Web that enables data to be shared and reused across applications, enterprises, and communities by providing a common framework that allows data to be linked and queried semantically. It is often associated with Linked Data, RDF (Resource Description Framework), OWL (Web Ontology Language), and SPARQL.

Features: RDF triples, ontologies (OWL/RDFS), SPARQL, reasoning.
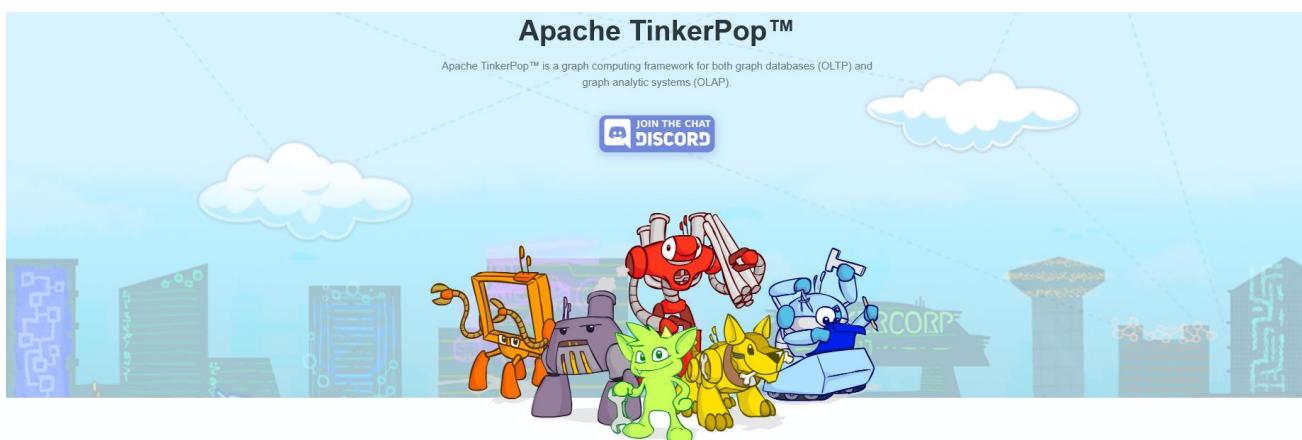
Q2. What is Apache TinkerPop?

Apache TinkerPop is an open-source graph computing framework that provides both a graph database abstraction (the property graph model) and a graph traversal language (Gremlin) for querying and analyzing graph data. When combined, Semantic Web technologies can be implemented or integrated with Apache TinkerPop to enable semantic reasoning, RDF-like triples, and ontology-based traversals over property graphs.

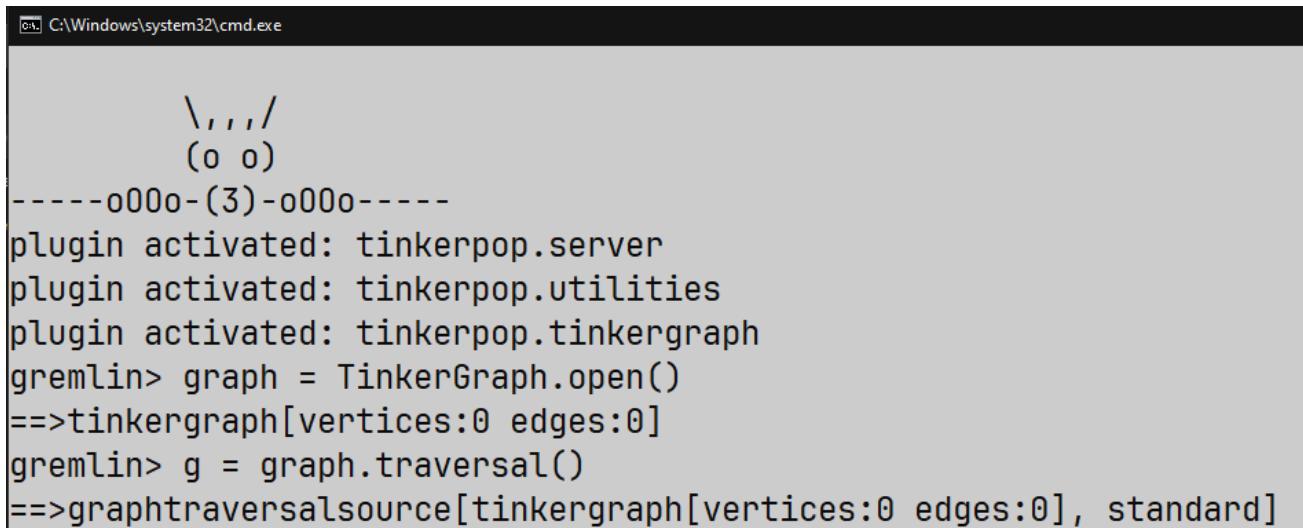**Features:** Property graph model, multi-system support, OLAP/OLTP.

Q3. What is Gremlin?

Gremlin is the graph traversal language of Apache TinkerPop. Gremlin is a functional, data-flow language that enables users to succinctly express complex traversals on (or queries of) their application's property graph. Every Gremlin traversal is composed of a sequence of (potentially nested) steps.

Features: Unified traversal language, works across graph systems.

Q4. Demonstrate the graph and nodes with relationships and attributes.

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         (o o)
-----oOOo-(3)-oOOo-----
plugin activated: tinkerpop.server
plugin activated: tinkerpop.utilities
plugin activated: tinkerpop.tinkergraph
gremlin> graph = TinkerGraph.open()
==>tinkergraph[vertices:0 edges:0]
gremlin> g = graph.traversal()
==>graphtraversalsource[tinkergraph[vertices:0 edges:0], standard]
```
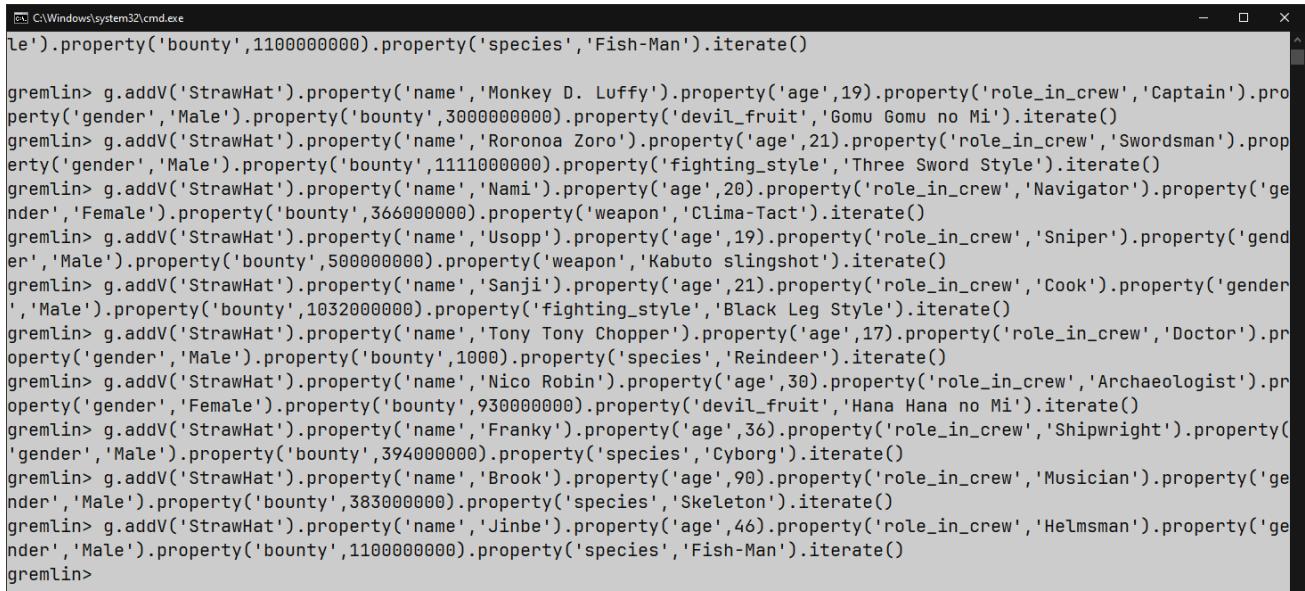
Initializing the graph

```
g.addV('StrawHat').property('name','Monkey D.
Luffy').property('age',19).property('role_in_crew','Captain').property('gender','Male').pr
operty('bounty',3000000000).property('devil_fruit','Gomu Gomu no Mi').iterate()
g.addV('StrawHat').property('name','Roronoa
Zoro').property('age',21).property('role_in_crew','Swordsman').property('gender','Male').p
roperty('bounty',1111000000).property('fighting_style','Three Sword Style').iterate()
g.addV('StrawHat').property('name','Nami').property('age',20).property('role_in_crew','Nav
igator').property('gender','Female').property('bounty',366000000).property('weapon','Clima
-Tact').iterate()
g.addV('StrawHat').property('name','Usopp').property('age',19).property('role_in_crew','Sn
iper').property('gender','Male').property('bounty',500000000).property('weapon','Kabuto
slingshot').iterate()
g.addV('StrawHat').property('name','Sanji').property('age',21).property('role_in_crew','Co
ok').property('gender','Male').property('bounty',1032000000).property('fighting_style','Bl
ack Leg Style').iterate()

g.addV('StrawHat').property('name','Tony Tony
Chopper').property('age',17).property('role_in_crew','Doctor').property('gender','Male').p
roperty('bounty',1000).property('species','Reindeer').iterate()
g.addV('StrawHat').property('name','Nico
Robin').property('age',30).property('role_in_crew','Archaeologist').property('gender','Fem
ale').property('bounty',930000000).property('devil_fruit','Hana Hana no Mi').iterate()

g.addV('StrawHat').property('name','Franky').property('age',36).property('role_in_crew','S
hipwright').property('gender','Male').property('bounty',394000000).property('species','Cyb
org').iterate()

g.addV('StrawHat').property('name','Brook').property('age',90).property('role_in_crew','Mu
sician').property('gender','Male').property('bounty',383000000).property('species','Skelet
on').iterate()

g.addV('StrawHat').property('name','Jinbe').property('age',46).property('role_in_crew','He
lmsman').property('gender','Male').property('bounty',1100000000).property('species','Fish-
Man').iterate()
```
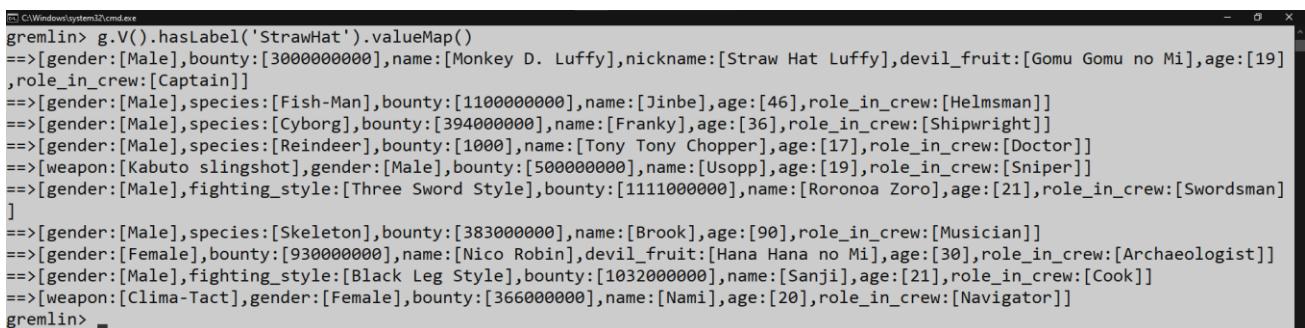
```
C:\Windows\system32\cmd.exe                                              —   □   ×
le').property('bounty',1100000000).property('species','Fish-Man').iterate()

gremlin> g.addV('StrawHat').property('name','Monkey D. Luffy').property('age',19).property('role_in_crew','Captain').pro
perty('gender','Male').property('bounty',3000000000).property('devil_fruit','Gomu Gomu no Mi').iterate()
gremlin> g.addV('StrawHat').property('name','Roronoa Zoro').property('age',21).property('role_in_crew','Swordsman').prop
erty('gender','Male').property('bounty',1111000000).property('fighting_style','Three Sword Style').iterate()
gremlin> g.addV('StrawHat').property('name','Nami').property('age',20).property('role_in_crew','Navigator').property('ge
nder','Female').property('bounty',366000000).property('weapon','Clima-Tact').iterate()
gremlin> g.addV('StrawHat').property('name','Usopp').property('age',19).property('role_in_crew','Sniper').property('gend
er','Male').property('bounty',500000000).property('weapon','Kabuto slingshot').iterate()
gremlin> g.addV('StrawHat').property('name','Sanji').property('age',21).property('role_in_crew','Cook').property('gender
','Male').property('bounty',1032000000).property('fighting_style','Black Leg Style').iterate()
gremlin> g.addV('StrawHat').property('name','Tony Tony Chopper').property('age',17).property('role_in_crew','Doctor').pr
operty('gender','Male').property('bounty',1000).property('species','Reindeer').iterate()
gremlin> g.addV('StrawHat').property('name','Nico Robin').property('age',30).property('role_in_crew','Archaeologist').pr
operty('gender','Female').property('bounty',930000000).property('devil_fruit','Hana Hana no Mi').iterate()
gremlin> g.addV('StrawHat').property('name','Franky').property('age',36).property('role_in_crew','Shipwright').property(
'gender','Male').property('bounty',394000000).property('species','Cyborg').iterate()
gremlin> g.addV('StrawHat').property('name','Brook').property('age',90).property('role_in_crew','Musician').property('ge
nder','Male').property('bounty',383000000).property('species','Skeleton').iterate()
gremlin> g.addV('StrawHat').property('name','Jinbe').property('age',46).property('role_in_crew','Helmsman').property('ge
nder','Male').property('bounty',1100000000).property('species','Fish-Man').iterate()
gremlin>
```

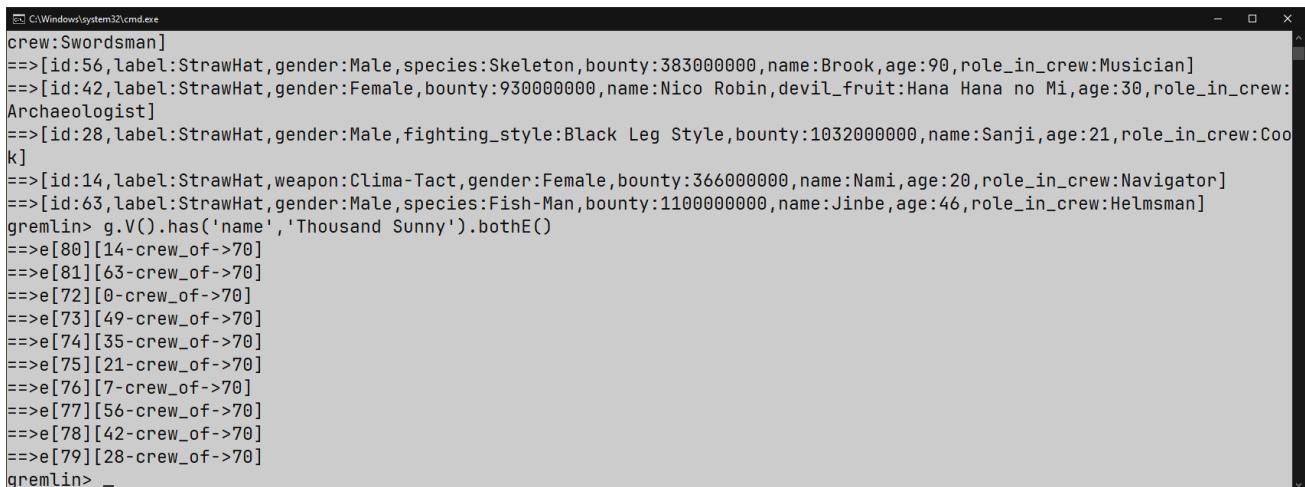**Adding Node 'Luffy' and all crew members**

```
C:\Windows\system32\cmd.exe                                              —   □   ×
gremlin> g.V().hasLabel('StrawHat').valueMap()
==>[gender:[Male],bounty:[3000000000],name:[Monkey D. Luffy],nickname:[Straw Hat Luffy],devil_fruit:[Gomu Gomu no Mi],age:[19]
,role_in_crew:[Captain]]
==>[gender:[Male],species:[Fish-Man],bounty:[1100000000],name:[Jinbe],age:[46],role_in_crew:[Helmsman]]
==>[gender:[Male],species:[Cyborg],bounty:[394000000],name:[Franky],age:[36],role_in_crew:[Shipwright]]
==>[gender:[Male],species:[Reindeer],bounty:[1000],name:[Tony Tony Chopper],age:[17],role_in_crew:[Doctor]]
==>[weapon:[Kabuto slingshot],gender:[Male],bounty:[500000000],name:[Usopp],age:[19],role_in_crew:[Sniper]]
==>[gender:[Male],fighting_style:[Three Sword Style],bounty:[1111000000],name:[Roronoa Zoro],age:[21],role_in_crew:[Swordsman]
]
==>[gender:[Male],species:[Skeleton],bounty:[383000000],name:[Brook],age:[90],role_in_crew:[Musician]]
==>[gender:[Female],bounty:[930000000],name:[Nico Robin],devil_fruit:[Hana Hana no Mi],age:[30],role_in_crew:[Archaeologist]]
==>[gender:[Male],fighting_style:[Black Leg Style],bounty:[1032000000],name:[Sanji],age:[21],role_in_crew:[Cook]]
==>[weapon:[Clima-Tact],gender:[Female],bounty:[366000000],name:[Nami],age:[20],role_in_crew:[Navigator]]
gremlin>
```

Querying all nodes

```
C:\Windows\system32\cmd.exe                                              —   □   ×
crew:Swordsman]
==>[id:56,label:StrawHat,gender:Male,species:Skeleton,bounty:383000000,name:Brook,age:90,role_in_crew:Musician]
==>[id:42,label:StrawHat,gender:Female,bounty:930000000,name:Nico Robin,devil_fruit:Hana Hana no Mi,age:30,role_in_crew:
Archaeologist]
==>[id:28,label:StrawHat,gender:Male,fighting_style:Black Leg Style,bounty:1032000000,name:Sanji,age:21,role_in_crew:Coo
k]
==>[id:14,label:StrawHat,weapon:Clima-Tact,gender:Female,bounty:366000000,name:Nami,age:20,role_in_crew:Navigator]
==>[id:63,label:StrawHat,gender:Male,species:Fish-Man,bounty:1100000000,name:Jinbe,age:46,role_in_crew:Helmsman]
gremlin> g.V().has('name','Thousand Sunny').bothE()
==>e[80][14-crew_of->70]
==>e[81][63-crew_of->70]
==>e[72][0-crew_of->70]
==>e[73][49-crew_of->70]
==>e[74][35-crew_of->70]
==>e[75][21-crew_of->70]
==>e[76][7-crew_of->70]
==>e[77][56-crew_of->70]
==>e[78][42-crew_of->70]
==>e[79][28-crew_of->70]
gremlin>
```

Added 'Thousand Sunny' Node as parent to all crew member nodes

1. THOUSAND SUNNY (Ship)

Node ID: 70

Label: Ship

Properties:

- name: Thousand Sunny
- type: Caravel
- builder: Franky
- captain: Monkey D. Luffy
- status: Active
- ship_class: Battle Caravel
- first_appearance: Chapter 435
- special_features: Coup de Burst, Gaon Cannon
- previous_ship: Going Merry

2. MONKEY D. LUFFY (Captain)

Node ID: 0

Label: StrawHat

Properties:

- name: Monkey D. Luffy
- age: 19
- role_in_crew: Captain
- gender: Male
- bounty: 3,000,000,000
- devil_fruit: Gomu Gomu no Mi
- nickname: Straw Hat Luffy
- dream: To become Pirate King
- hometown: Foosha Village
- epithet: Fifth Emperor

3. RORONOA ZORO (Swordsman)

Node ID: 7

Label: StrawHat

Properties:

- name: Roronoa Zoro
- age: 21
- role_in_crew: Swordsman / Combatant
- gender: Male
- bounty: 1,111,000,000
- fighting_style: Three Sword Style
- nickname: Pirate Hunter
- swords: Wado Ichimonji, Sandai Kitetsu, Enma
- dream: To become greatest swordsman
- epithet: King of Hell

4. NAMI (Navigator)

Node ID: 14

Label: StrawHat

Properties:

- name: Nami
- age: 20
- role_in_crew: Navigator
- gender: Female
- bounty: 366,000,000
- weapon: Clima-Tact
- nickname: Cat Burglar
- specialty: Cartography, Weather Science
- dream: To map the entire world
- hometown: Cocoyashi Village

5. USOPP (Sniper)

Node ID: 21

Label: StrawHat

Properties:

- name: Usopp
- age: 19
- role_in_crew: Sniper
- gender: Male
- bounty: 500,000,000
- weapon: Kabuto slingshot
- nickname: Sogeking, God Usopp
- dream: To become brave warrior of the sea
- hometown: Syrup Village
- father: Yasopp (Red Hair Pirates)

6. SANJI (Cook)

Node ID: 28
Label: StrawHat
Properties:
- name: Sanji
- age: 21
- role_in_crew: Cook
- gender: Male
- bounty: 1,032,000,000
- fighting_style: Black Leg Style
- nickname: Black Leg
- dream: To find All Blue
- special_skill: Sky Walk
- family: Vinsmoke Family
- epithet: Hunter

7. TONY TONY CHOPPER (Doctor)

Node ID: 35
Label: StrawHat
Properties:
- name: Tony Tony Chopper
- age: 17
- role_in_crew: Doctor
- gender: Male
- bounty: 1,000
- species: Reindeer
- devil_fruit: Hito Hito no Mi
- nickname: Cotton Candy Lover
- dream: To cure all diseases
- transformations: 7 forms
- hometown: Drum Island

8. NICO ROBIN (Archaeologist)

Node ID: 42
Label: StrawHat
Properties:
- name: Nico Robin
- age: 30
- role_in_crew: Archaeologist
- gender: Female
- bounty: 930,000,000
- devil_fruit: Hana Hana no Mi
- nickname: Devil Child
- dream: To find True History (Rio Poneglyph)
- epithet: Light of the Revolution
- hometown: Ohara (destroyed)

9. FRANKY (Shipwright)

Node ID: 49
Label: StrawHat
Properties:
- name: Franky
- age: 36
- role_in_crew: Shipwright
- gender: Male
- bounty: 394,000,000
- species: Cyborg
- nickname: Iron Man
- dream: To build dream ship that sails entire world
- creator: Built Thousand Sunny
- catchphrase: "SUUUUUPER!"
- hometown: Water 7

10. BROOK (Musician)

Node ID: 56
Label: StrawHat
Properties:
- name: Brook
- age: 90
- role_in_crew: Musician
- gender: Male
- bounty: 383,000,000
- species: Skeleton
- devil_fruit: Yomi Yomi no Mi
- nickname: Soul King
- dream: To reunite with Laboon
- instrument: Violin

- epithet: Dead Bones
- former_captain: Rumbar Pirates
- gender: Male
- bounty: 1,100,000,000
- species: Fish-Man
- fighting_style: Fish-Man Karate
- nickname: First Son of the Sea
- dream: Equality between humans and fish-men
- former_position: Shichibukai, Sun Pirates Captain
- epithet: Knight of the Sea

11. JINBE (Helmsman)

Node ID: 63
Label: StrawHat
Properties:

- name: Jinbe
- age: 46
- role_in_crew: Helmsman

EDGE RELATIONSHIPS

Relationship Type: member_of
Direction: StrawHat → Ship
Count: 10 edges
From-To:

- Monkey D. Luffy → Thousand Sunny
- Roronoa Zoro → Thousand Sunny
- Nami → Thousand Sunny
- Usopp → Thousand Sunny
- Sanji → Thousand Sunny
- Tony Tony Chopper → Thousand Sunny
- Nico Robin → Thousand Sunny
- Franky → Thousand Sunny
- Brook → Thousand Sunny
- Jinbe → Thousand Sunny

GRAPH SUMMARY

- Total Nodes: 11
- Total Edges: 10
- Graph Type: Directed Property Graph
- Topology: Star/Hub-and-Spoke
- Central Node: Thousand Sunny
- Leaf Nodes: 10 Straw Hat members

Conclusion

Apache TinkerPop and Gremlin provide an effective approach to implementing the Semantic Web by representing data as graphs. This method simplifies relationship- based queries, improves clarity, and overcomes the limitations of traditional relational databases.