MONASH University
Information Technology

ASSESSMENT COVER SHEET

Student ID number	30864941
Given Name	Andrew
Family name	Lee

Unit Name and Code:	**FIT3176 Advanced Database Design**
Campus:	**Clayton**
Assignment Title:	FIT3176 Individual Assignment - Sem 2/2023 (Weight: 30%)
Name of Lecturer:	**Farah Kabir**
Name of Tutor:	**Farah Kabir**
Tutorial Day and Time:	**Tuesday 5PM-7PM**
Phone Number:	**0405245648**
Email Address:	**Alee0050@student.monash.edu**

Has any part of this assignment been previously submitted as part of another unit/course? ☐ Yes ☐ No

Due Date:	**20th of Oct**	Date Submitted:	29th of Oct

All work must be submitted by the due date. If an extension of work is granted this must be specified with the signature of the lecturer/tutor.

Extension granted until (date)_____29th of Oct_____ Signature of lecturer/tutor _____Monash Connect_____

Please note that it is your responsibility to retain copies of your assessments.

Intentional plagiarism or collusion amounts to cheating under Part 7 of the Monash University (Council) Regulations

Plagiarism: Plagiarism means taking and using another person's ideas or manner of expressing them and passing them off as one's own. For example, by failing to give appropriate acknowledgement. The material used can be from any source (staff, students or the internet, published and unpublished works).

Collusion: Collusion means unauthorised collaboration with another person on assessable written, oral or practical work and includes paying another person to complete all or part of the work.

Where there are reasonable grounds for believing that intentional plagiarism or collusion has occurred, this will be reported to the Associate Dean (Education) or delegate, who may disallow the work concerned by prohibiting assessment or refer the matter to the Faculty Discipline Panel for a hearing.

Student Statement:

- I have read the university's Student Academic Integrity Policy and Procedures.
- I understand the consequences of engaging in plagiarism and collusion as described in Part 7 of the Monash University (Council) Regulations http://adm.monash.edu/legal/legislation/statutes
- have taken proper care to safeguard this work and made all reasonable efforts to ensure it could not be copied.
- No part of this assignment has been previously submitted as part of another unit/course.
- I acknowledge and agree that the assessor of this assignment may for the purposes of assessment, reproduce the assignment and:
  - i. provide to another member of faculty and any external marker; and/or
  - ii. submit it to a text matching software; and/or
  - iii. submit it to a text matching software which may then retain a copy of the assignment on its database for the purpose of future plagiarism checking.
- I certify that I have not plagiarised the work of others or participated in unauthorised collaboration when preparing this assignment.

Signature .....Andrew Lee..... Date……29/10/2023……

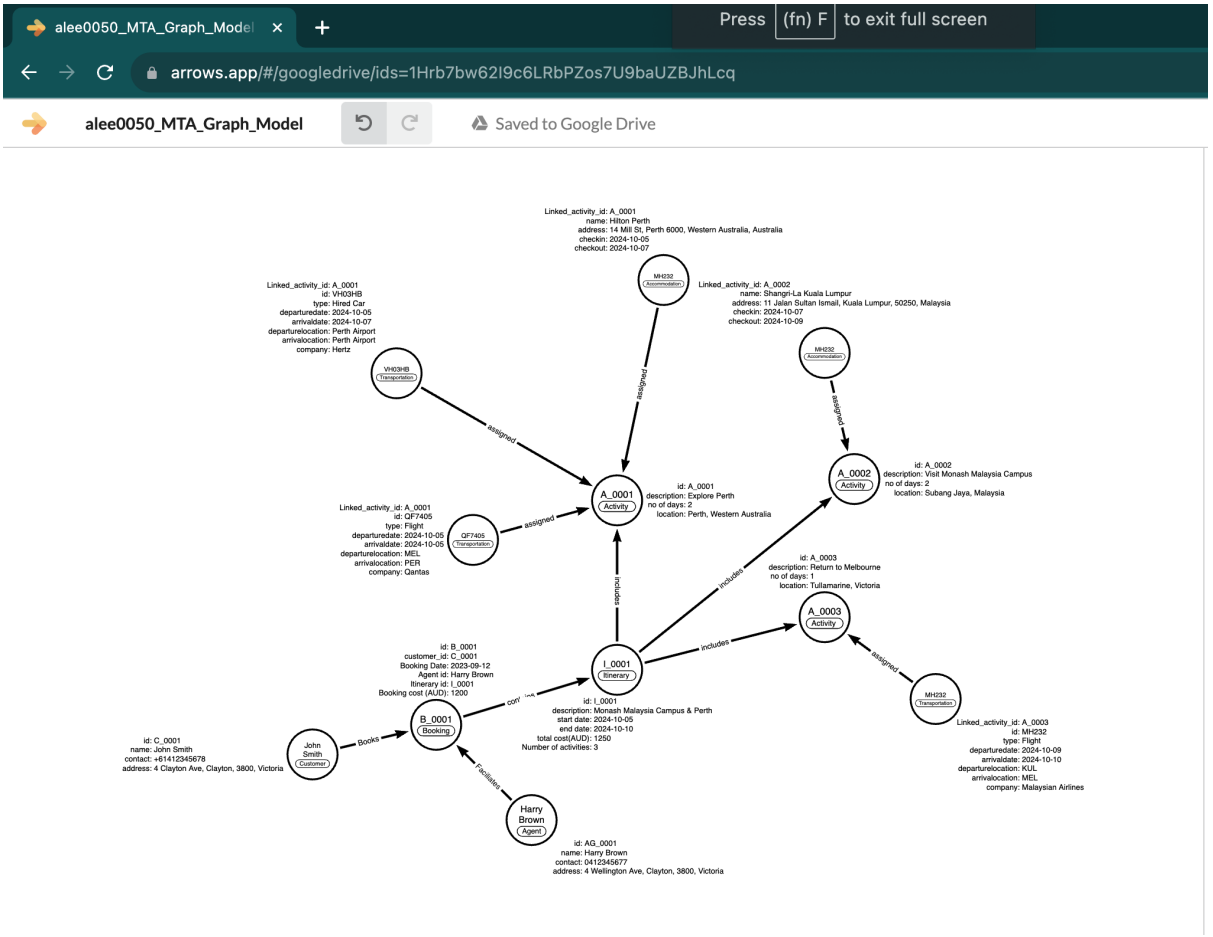
* delete (iii) if not applicable

The information on this form is collected for the primary purpose of assessing your assignment and ensuring the academic integrity requirements of the University are met. *Other purposes of collection include recording your plagiarism and collusion declaration, attending to course and administrative matters and statistical analyses. If you choose not to complete all the questions on this form it may not be possible for Monash University to assess your assignment. You have a right to access personal information that Monash University holds about you, subject to any exceptions in relevant legislation. If you wish to seek access to your personal information or inquire about the handling of your personal information, please contact the University Privacy Officer: privacyofficer@adm.monash.edu.au*

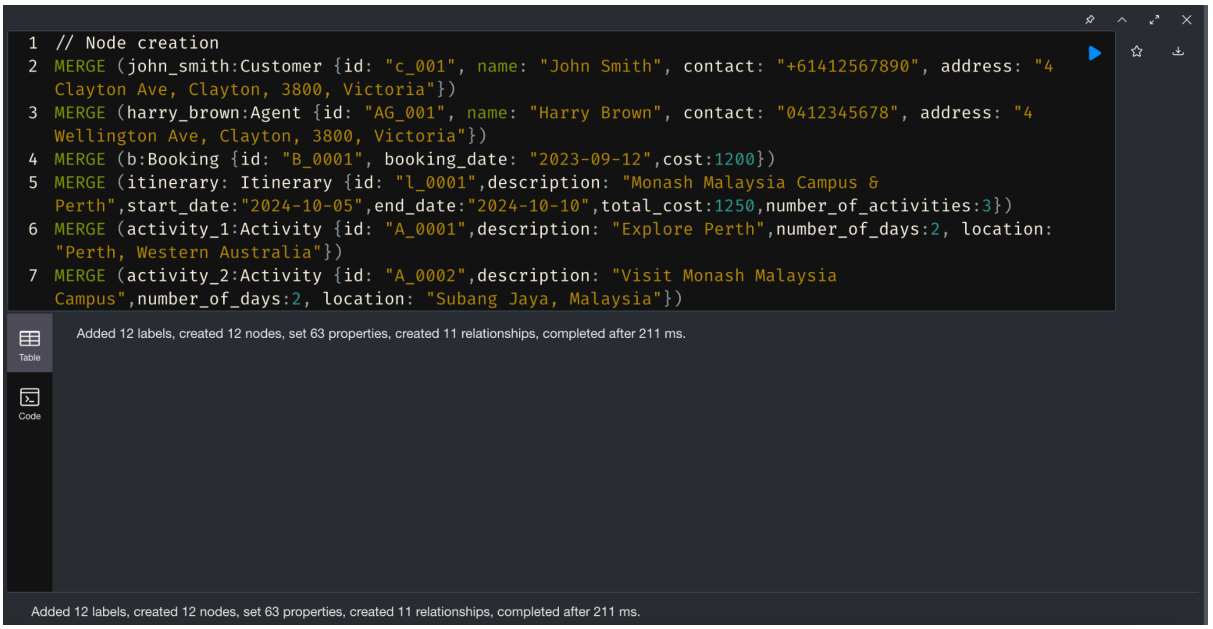
Updated: 17 Jun 2014

A1:

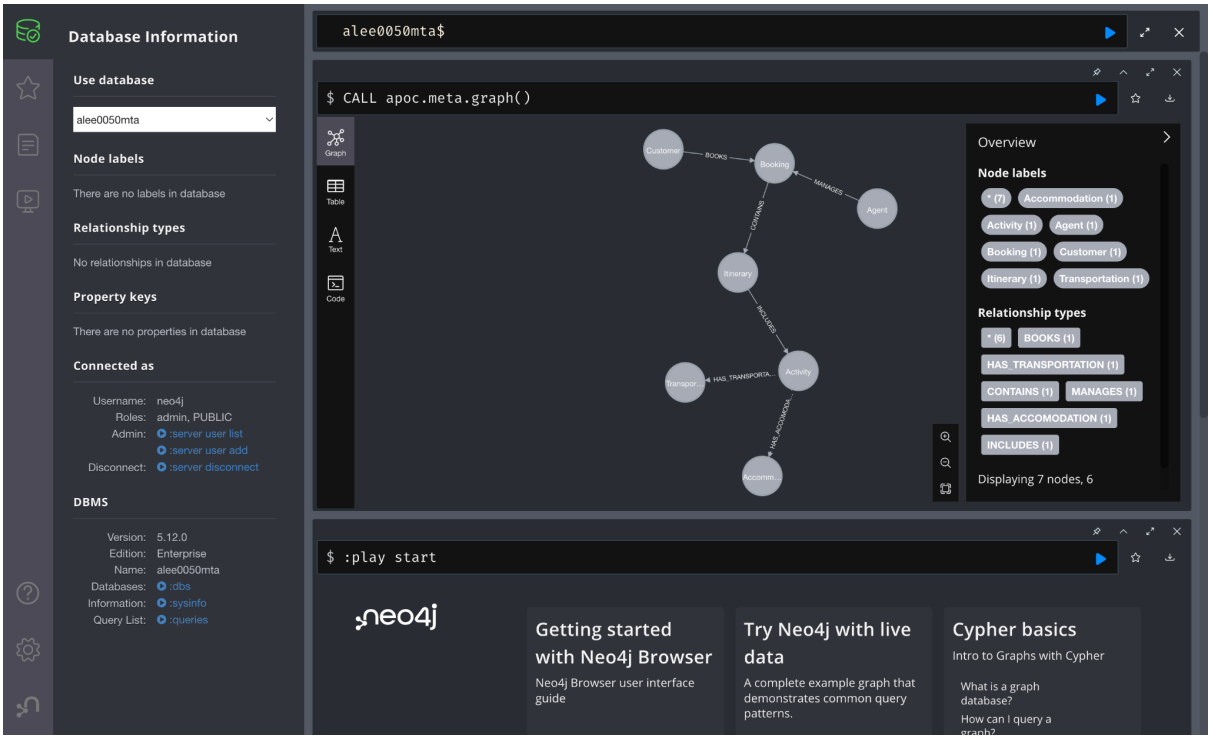
https://arrows.app/#/googledrive/ids=1Hrb7bw62l9c6LRbPZos7U9baUZBJhLcq



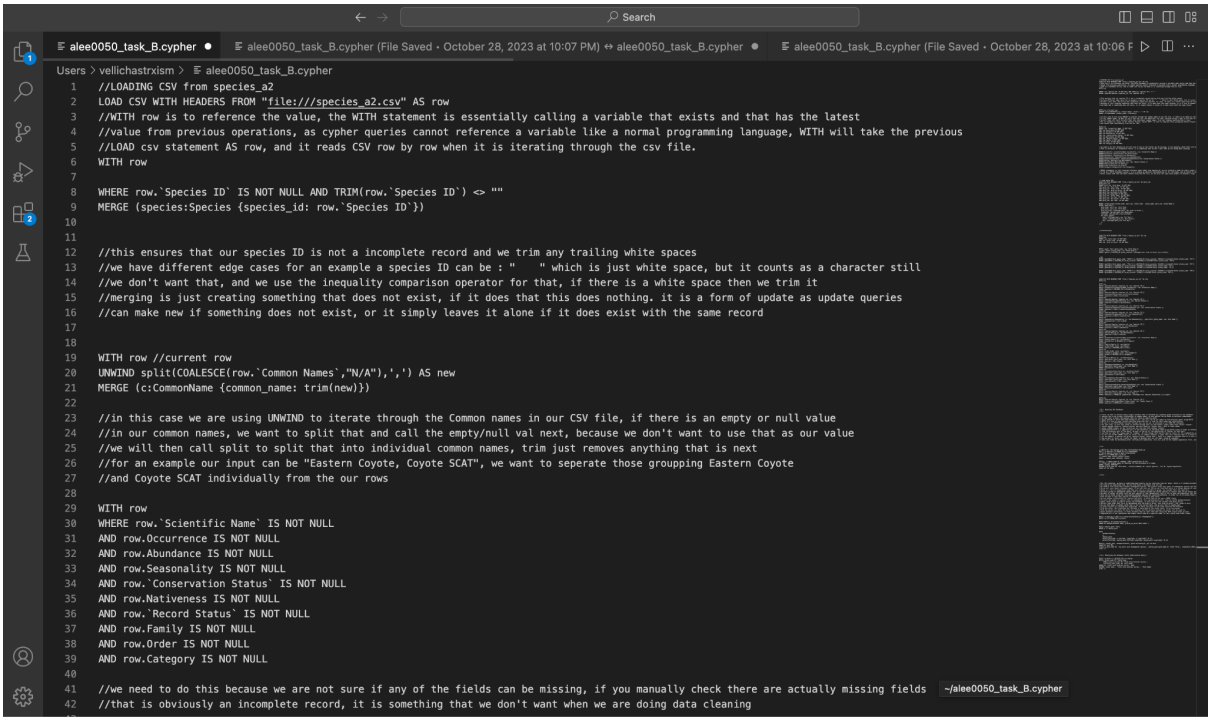
A1 results:

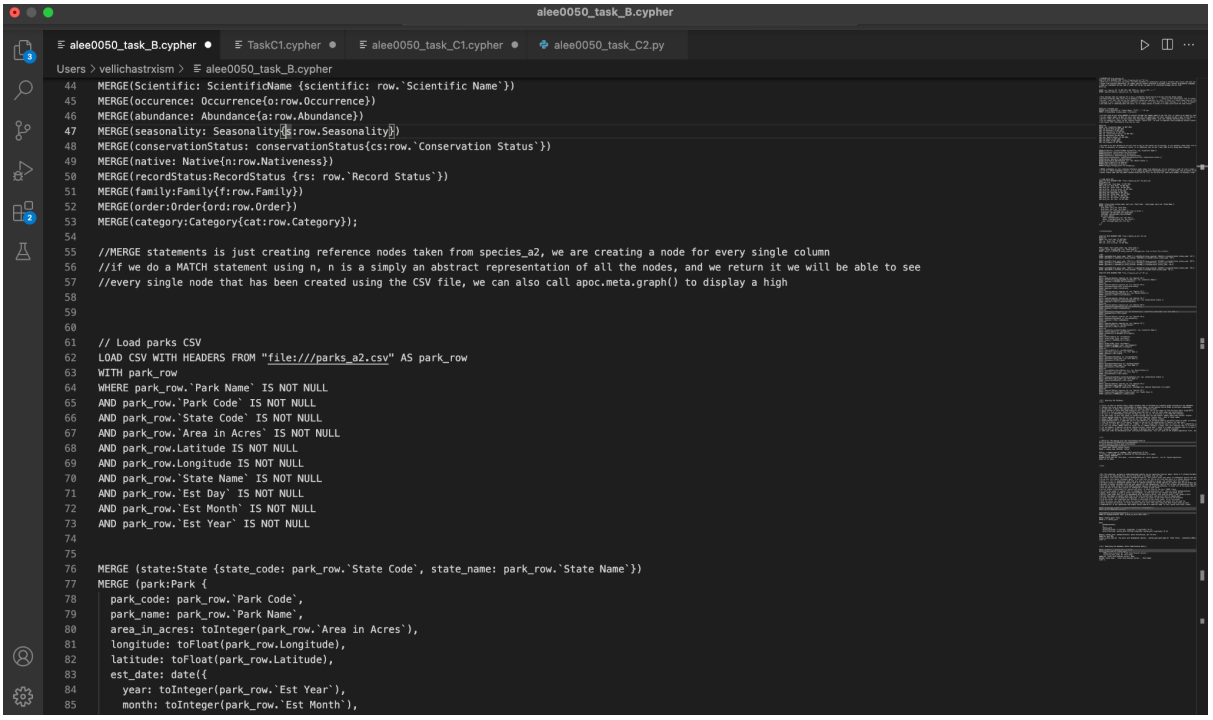


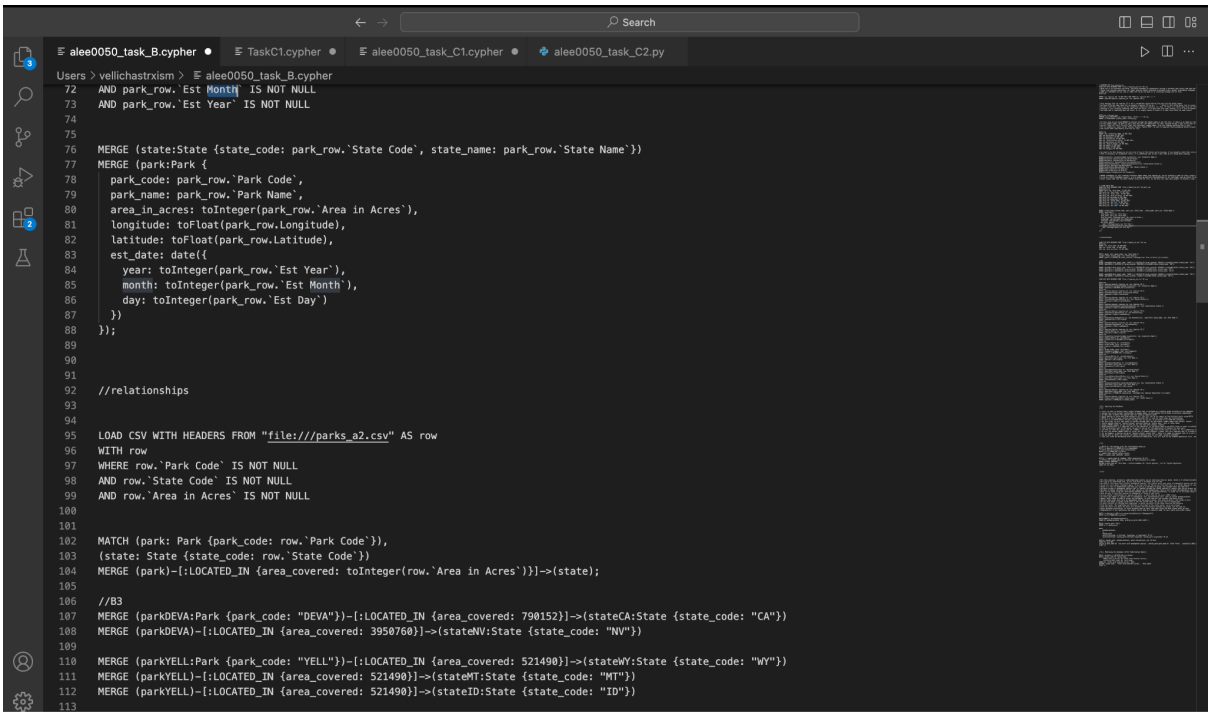
APOC calls:

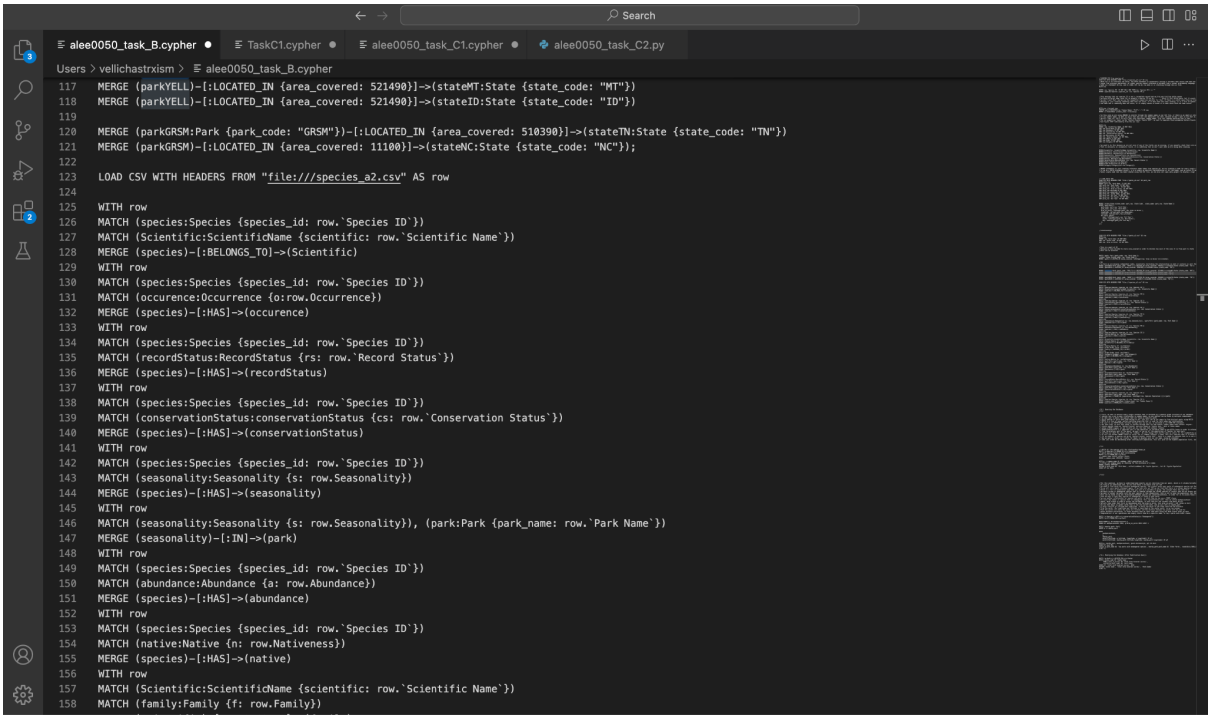


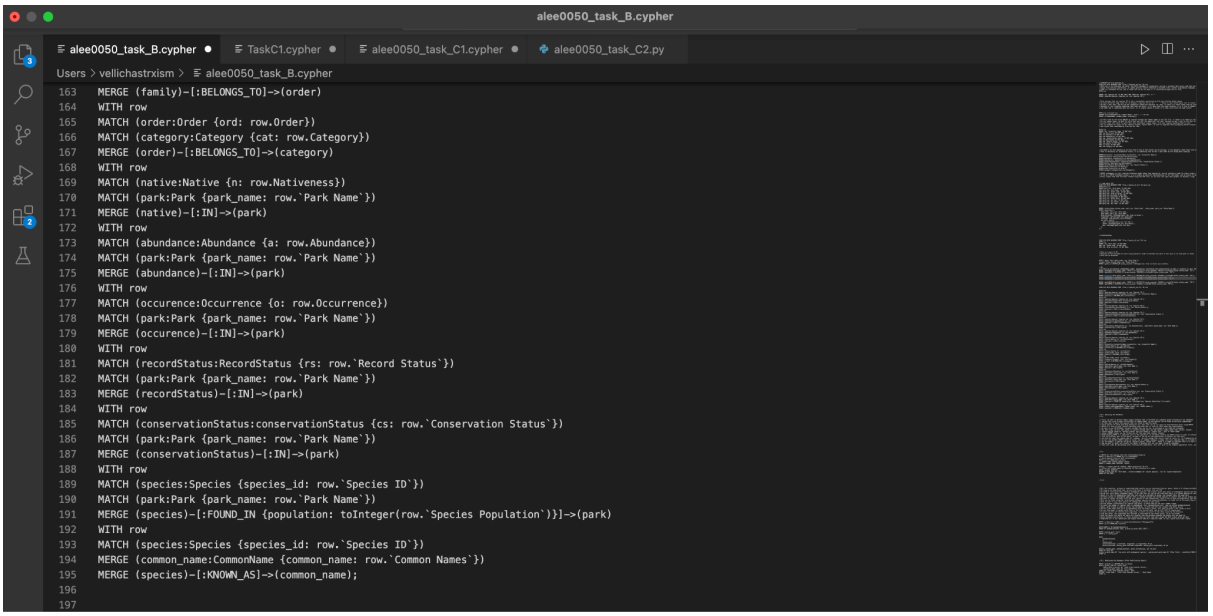
B.1. Creating the Database:



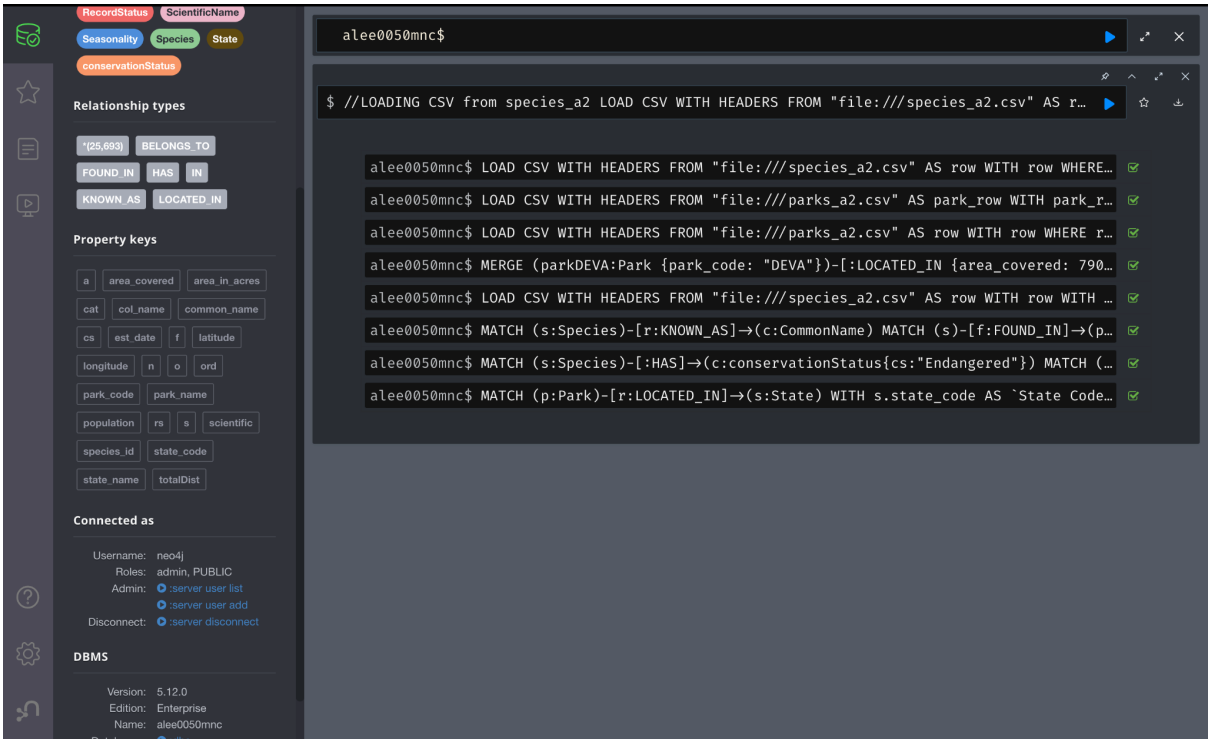

alee0050_task_B.cypher
alee0050_task_B.cypher
TaskC1.cypher
alee0050_task_C1.cypher
alee0050_task_C2.py
Users > vellichastrxism > alee0050_task_B.cypher
MERGE(Scientific: ScientificName {scientific: row.`Scientific Name`})
MERGE(occurence: Occurrence{o:row.Occurrence})
MERGE(abundance: Abundance{a:row.Abundance})
MERGE(seasonality: Seasonality{s:row.Seasonality})
MERGE(conservationStatus: conservationStatus{cs:row.`Conservation Status`})
MERGE(native: Native{n:row.Nativeness})
MERGE(recordStatus:RecordStatus {rs: row.`Record Status`})
MERGE(family:Family{f:row.Family})
MERGE(order:Order{ord:row.Order})
MERGE(category:Category{cat:row.Category});
//MERGE statements is just creating reference nodes taken from species_a2, we are creating a node for every single column
//if we do a MATCH statement using n, n is a simply an abstract representation of all the nodes, and we return it we will be able to see
//every single node that has been created using the CSV file, we can also call apoc.meta.graph() to display a high
// Load parks CSV
LOAD CSV WITH HEADERS FROM "file:///parks_a2.csv" AS park_row
WITH park_row
WHERE park_row.`Park Name` IS NOT NULL
AND park_row.`Park Code` IS NOT NULL
AND park_row.`State Code` IS NOT NULL
AND park_row.`Area in Acres` IS NOT NULL
AND park_row.Latitude IS NOT NULL
AND park_row.Longitude IS NOT NULL
AND park_row.`State Name` IS NOT NULL
AND park_row.`Est Day` IS NOT NULL
AND park_row.`Est Month` IS NOT NULL
AND park_row.`Est Year` IS NOT NULL
MERGE (state:State {state_code: park_row.`State Code`, state_name: park_row.`State Name`})
MERGE (park:Park {
park_code: park_row.`Park Code`,
park_name: park_row.`Park Name`,
area_in_acres: toInteger(park_row.`Area in Acres`),
longitude: toFloat(park_row.Longitude),
latitude: toFloat(park_row.Latitude),
est_date: date({
year: toInteger(park_row.`Est Year`),
month: toInteger(park_row.`Est Month`),


Search
alee0050_task_B.cypher
TaskC1.cypher
alee0050_task_C1.cypher
alee0050_task_C2.py
Users > vellichastrxism > alee0050_task_B.cypher
AND park_row.`Est Month` IS NOT NULL
AND park_row.`Est Year` IS NOT NULL
MERGE (state:State {state_code: park_row.`State Code`, state_name: park_row.`State Name`})
MERGE (park:Park {
park_code: park_row.`Park Code`,
park_name: park_row.`Park Name`,
area_in_acres: toInteger(park_row.`Area in Acres`),
longitude: toFloat(park_row.Longitude),
latitude: toFloat(park_row.Latitude),
est_date: date({
year: toInteger(park_row.`Est Year`),
month: toInteger(park_row.`Est Month`),
day: toInteger(park_row.`Est Day`)
})
});
//relationships
LOAD CSV WITH HEADERS FROM "file:///parks_a2.csv" AS row
WITH row
WHERE row.`Park Code` IS NOT NULL
AND row.`State Code` IS NOT NULL
AND row.`Area in Acres` IS NOT NULL
MATCH (park: Park {park_code: row.`Park Code`}),
(state: State {state_code: row.`State Code`})
MERGE (park)-[:LOCATED_IN {area_covered: toInteger(row.`Area in Acres`)}]->(state);
//B3
MERGE (parkDEVA:Park {park_code: "DEVA"})-[:LOCATED_IN {area_covered: 790152}]->(stateCA:State {state_code: "CA"})
MERGE (parkDEVA)-[:LOCATED_IN {area_covered: 3950760}]->(stateNV:State {state_code: "NV"})
MERGE (parkYELL:Park {park_code: "YELL"})-[:LOCATED_IN {area_covered: 521490}]->(stateWY:State {state_code: "WY"})
MERGE (parkYELL)-[:LOCATED_IN {area_covered: 521490}]->(stateMT:State {state_code: "MT"})
MERGE (parkYELL)-[:LOCATED_IN {area_covered: 521490}]->(stateID:State {state_code: "ID"})

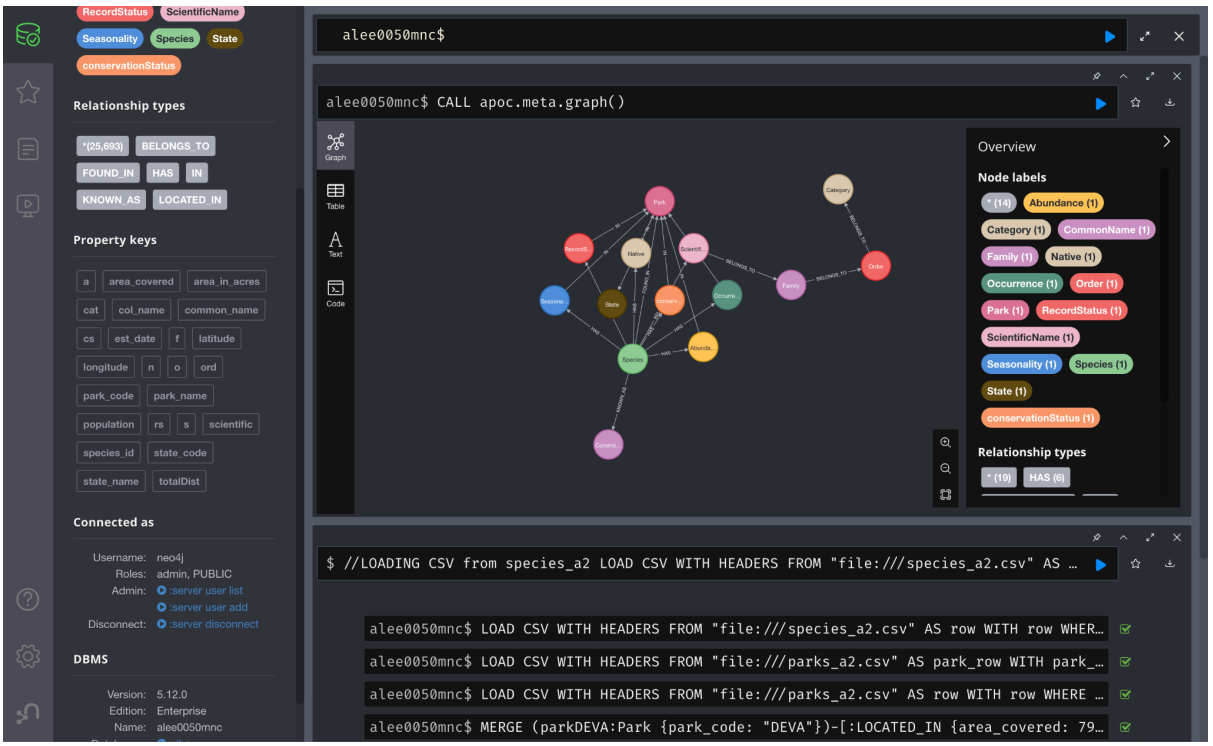

Search
alee0050_task_B.cypher
TaskC1.cypher
alee0050_task_C1.cypher
alee0050_task_C2.py
Users > vellichastrxism > alee0050_task_B.cypher
MERGE (parkYELL)-[:LOCATED_IN {area_covered: 521490}]->(stateMT:State {state_code: "MT"})
MERGE (parkYELL)-[:LOCATED_IN {area_covered: 521490}]->(stateID:State {state_code: "ID"})
MERGE (parkGRSM:Park {park_code: "GRSM"})-[:LOCATED_IN {area_covered: 510390}]->(stateTN:State {state_code: "TN"})
MERGE (parkGRSM)-[:LOCATED_IN {area_covered: 11100}]->(stateNC:State {state_code: "NC"});
LOAD CSV WITH HEADERS FROM "file:///species_a2.csv" AS row
WITH row
MATCH (species:Species {species_id: row.`Species ID`})
MATCH (Scientific:ScientificName {scientific: row.`Scientific Name`})
MERGE (species)-[:BELONGS_TO]->(Scientific)
WITH row
MATCH (species:Species {species_id: row.`Species ID`})
MATCH (occurence:Occurrence {o:row.Occurrence})
MERGE (species)-[:HAS]->(occurence)
WITH row
MATCH (species:Species {species_id: row.`Species ID`})
MATCH (recordStatus:RecordStatus {rs: row.`Record Status`})
MERGE (species)-[:HAS]->(recordStatus)
WITH row
MATCH (species:Species {species_id: row.`Species ID`})
MATCH (conservationStatus:conservationStatus {cs: row.`Conservation Status`})
MERGE (species)-[:HAS]->(conservationStatus)
WITH row
MATCH (species:Species {species_id: row.`Species ID`})
MATCH (seasonality:Seasonality {s: row.Seasonality})
MERGE (species)-[:HAS]->(seasonality)
WITH row
MATCH (seasonality:Seasonality {s: row.Seasonality}), (park:Park {park_name: row.`Park Name`})
MERGE (seasonality)-[:IN]->(park)
WITH row
MATCH (species:Species {species_id: row.`Species ID`})
MATCH (abundance:Abundance {a: row.Abundance})
MERGE (species)-[:HAS]->(abundance)
WITH row
MATCH (species:Species {species_id: row.`Species ID`})
MATCH (native:Native {n: row.Nativeness})
MERGE (species)-[:HAS]->(native)
WITH row
MATCH (Scientific:ScientificName {scientific: row.`Scientific Name`})
MATCH (family:Family {f: row.Family})


alee0050_task_B.cypher
alee0050_task_B.cypher
TaskC1.cypher
alee0050_task_C1.cypher
alee0050_task_C2.py
Users > vellichastrxism > alee0050_task_B.cypher
MERGE (family)-[:BELONGS_TO]->(order)
WITH row
MATCH (order:Order {ord: row.Order})
MATCH (category:Category {cat: row.Category})
MERGE (order)-[:BELONGS_TO]->(category)
WITH row
MATCH (native:Native {n: row.Nativeness})
MATCH (park:Park {park_name: row.`Park Name`})
MERGE (native)-[:IN]->(park)
WITH row
MATCH (abundance:Abundance {a: row.Abundance})
MATCH (park:Park {park_name: row.`Park Name`})
MERGE (abundance)-[:IN]->(park)
WITH row
MATCH (occurence:Occurrence {o: row.Occurrence})
MATCH (park:Park {park_name: row.`Park Name`})
MERGE (occurence)-[:IN]->(park)
WITH row
MATCH (recordStatus:RecordStatus {rs: row.`Record Status`})
MATCH (park:Park {park_name: row.`Park Name`})
MERGE (recordStatus)-[:IN]->(park)
WITH row
MATCH (conservationStatus:conservationStatus {cs: row.`Conservation Status`})
MATCH (park:Park {park_name: row.`Park Name`})
MERGE (conservationStatus)-[:IN]->(park)
WITH row
MATCH (species:Species {species_id: row.`Species ID`})
MATCH (park:Park {park_name: row.`Park Name`})
MERGE (species)-[:FOUND_IN {population: toInteger(row.`Species Population`)}]->(park)
WITH row
MATCH (species:Species {species_id: row.`Species ID`})
MERGE (common_name:CommonName {common_name: row.`Common Names`})
MERGE (species)-[:KNOWN_AS]->(common_name);

Results:



Visualisation of graph nodes and relationships when we call apoc.



B.2. Querying the Database:

(i)

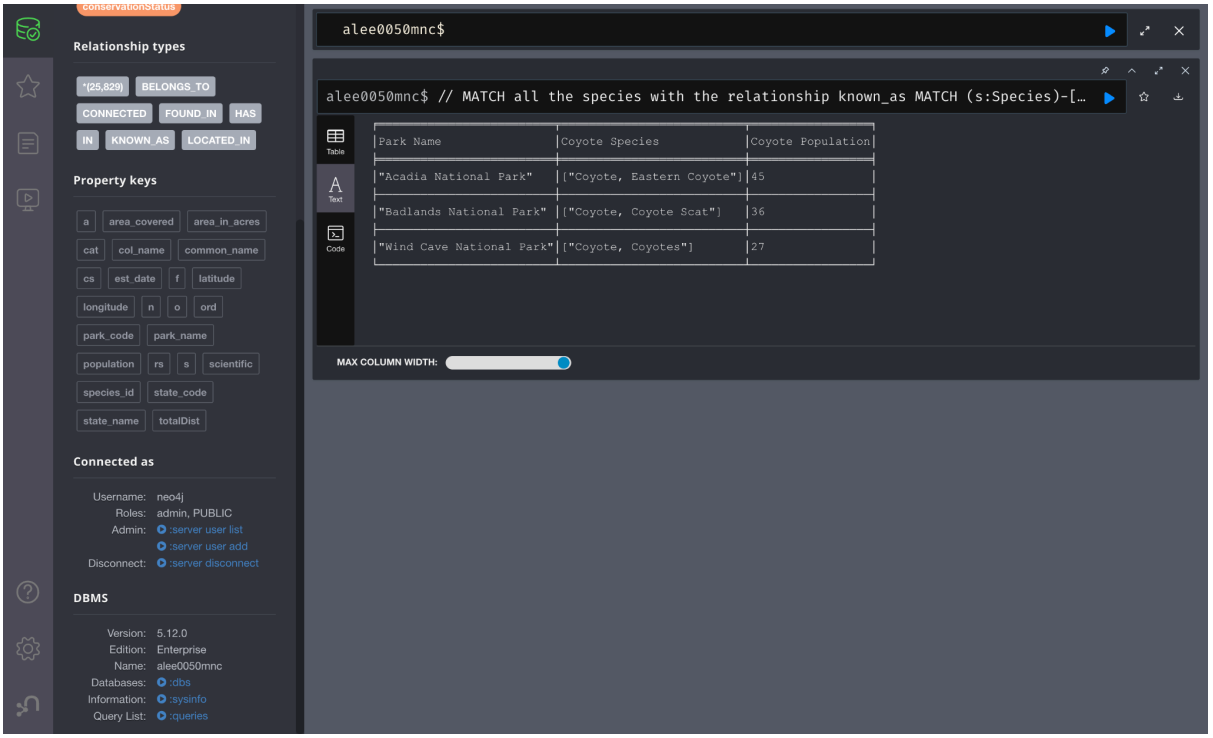
Code:

```
// MATCH all the species with the relationship known_as
MATCH (s:Species)-[r:KNOWN_AS]->(c:CommonName)
// match species found_in park relationship
MATCH (s)-[f:FOUND_IN]->(p:Park)
// common name should contain Coyote
WHERE c.common_name CONTAINS 'Coyote'

WITH p, c.common_name AS comName, SUM(f.population) AS tot
// Filter out single names by checking for the existence of a comma
WHERE comName CONTAINS ','
RETURN p.park_name AS `Park Name`, collect(comName) AS `Coyote Species`, tot AS `Coyote Population`
ORDER BY tot DESC;
```

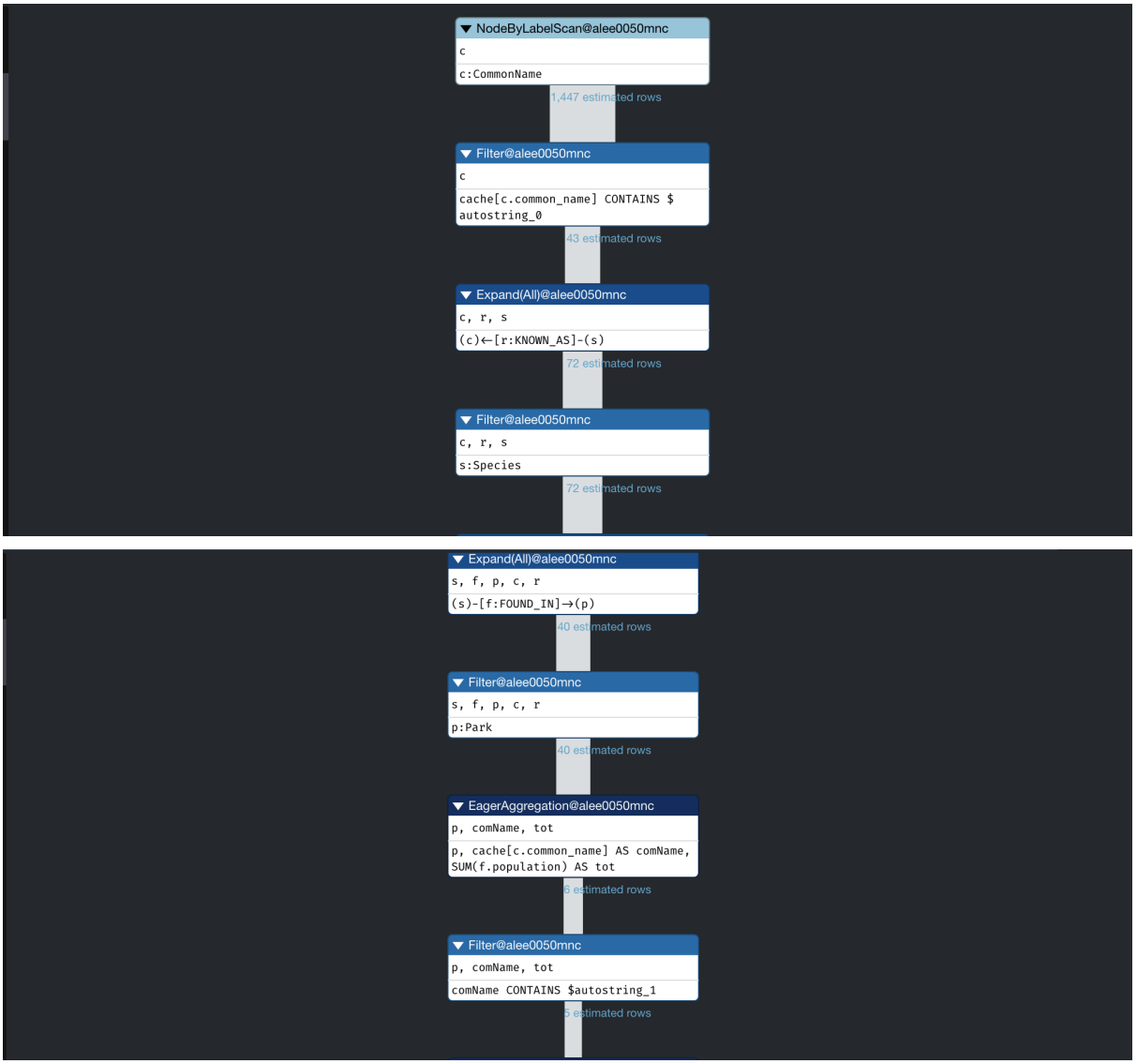
Code explanation:

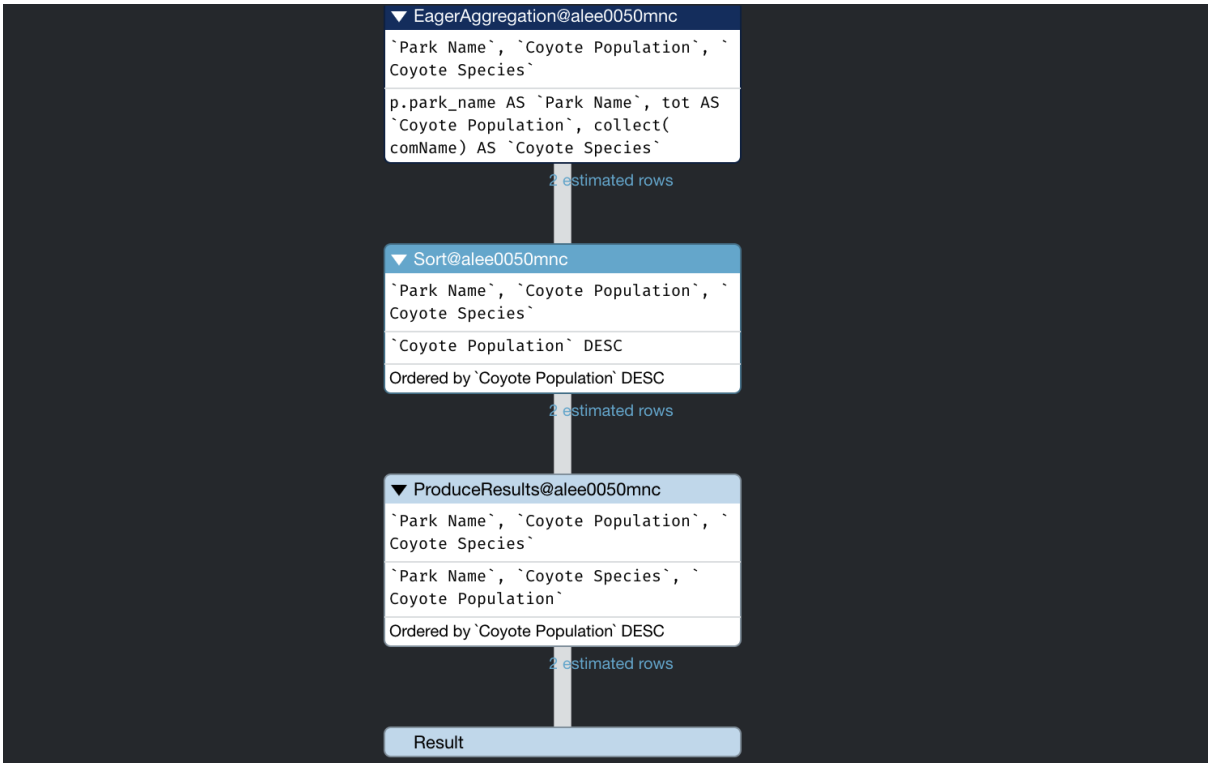
```
// First, we want to extract every single instance that is dictated by a general graph structure of our database
// species has a one to many relationship to common names, as one species can be known by multiple commonnames
// we then want to match the species that are found in specific parks
// which species of which park they belong to etc, this will set up our query to find distinct parks using MATCH
// MATCH is a form of grep, pattern matching algorithm that is used for both nodes and relationships
// We want to use MATCH Neo4j iterates through rows one by one, as dictated in our LOAD CSV statement.
// Our next step, we will tell neo4j to iterate through each row and lookfor common names that contain 'Coyote'.
// Coyote species known as "Eastern Coyote" and also known as "Coyote Scat," both of these names
// using a WHERE clause, we can filters out all the rows that contain 'Coyote.'
// Understanding WITH is a important part of the operation, as variables need to use WITH clause in order to reference the variables that were accessed
// from the previous part of the query. We want to sum up all the populations of Coyotes for each park,
// and then we label the common_name AS `comName`. We will change that shortly when we return it, for readability we use a name instead of referencing c.common_name
// we will use another WHERE clause to filter out if comName contains a comma, this will indicate that it is known by two names rather than one
// for an example, a species can go by "Eastern Coyote, Coyote SCAT", there is a comma to indicate that it is more than one name
// Now we want to return our results for Neo4j to display with our set name, using AS statement
// then just order by descending order starting with population, this will give us the highest population first, second highest etc
```

Results:



Execution plan:





(ii)

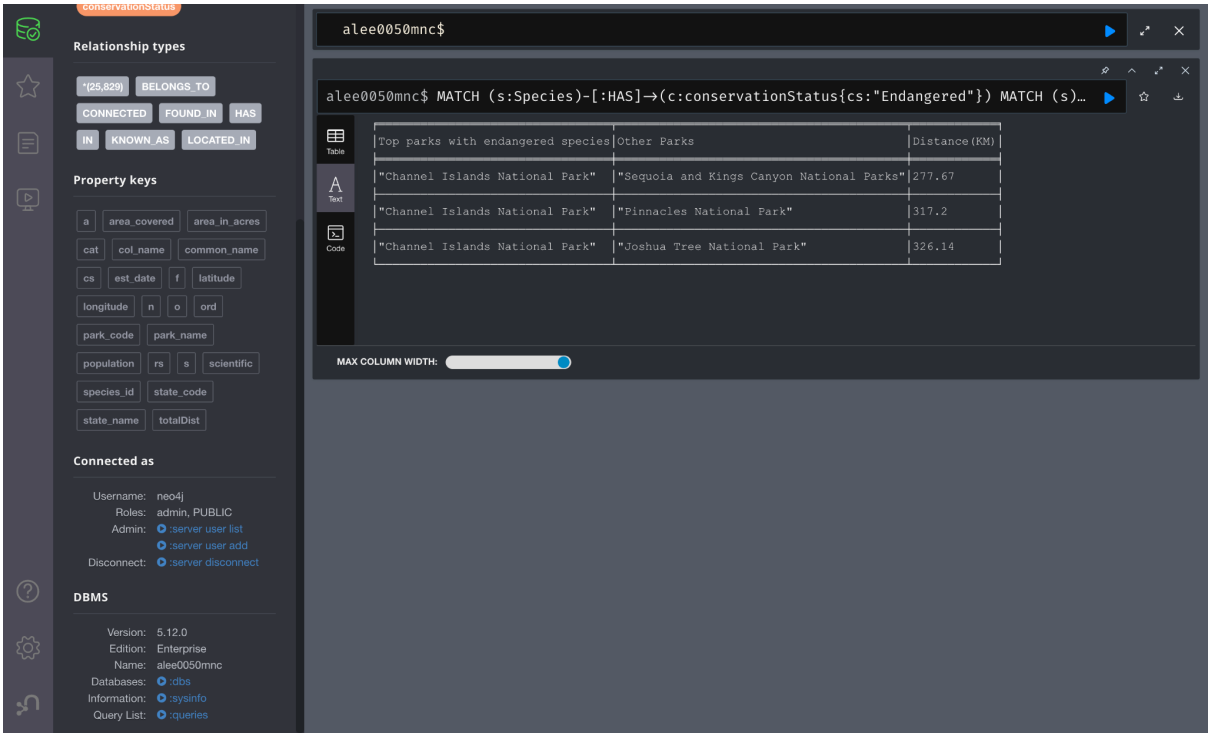
Code:

```
MATCH (s:Species)-[:HAS]->(c:conservationStatus{cs:"Endangered"})
MATCH (s)-[f:FOUND_IN]->(p:Park)

WITH COUNT(s) AS maxSpeciesCount,p
ORDER BY maxSpeciesCount DESC, p.area_in_acres DESC LIMIT 1

MATCH (nearby_park: Park)
WHERE p <> nearby_park

WITH
    maxSpeciesCount,
    p,
    nearby_park,
    point({latitude: p.latitude, longitude: p.longitude}) AS p1,
    point({latitude: nearby_park.latitude,longitude: nearby_park.longitude}) AS p2

WITH p, nearby_park, maxSpeciesCount, point.distance(p1, p2) AS dist
ORDER BY dist ASC
return p.park_name AS `Top parks with endangered species`, nearby_park.park_name AS `Other Parks`, round(dist/1000,2) AS `Distance(KM)`
LIMIT 3;
```

Code explanation:

```
//For this question, we have to understand what exactly we are returning from our query, which is 3 columns/variables
//As long as we understand that, we can find those 3 variables from our CSV
//we need to find parks that contains endangered species, the closest parks near parks of endangered species and the distance
//So we will use a match statement again, if we look into our CSV we can find that there is a column species of concern
//which is a form of enumeration type that you cast on a variable to group, the concept feels the same here
//we have a group of endangered species that is labeled through the column species of concern that we can access with CSV
//we want to output the parks with the most species of that enumeration, this is not to have the population, but the specific
//this can be found using the relationship between species and conservationStatus, in order for us to access those variables
//then we want to know what species of endangered is found in what parks
//we use another relationship for species and parks, in which then we can use a COUNT clause
//to count the number of species that is endangered, this representation will  then be called maxSpeciesCount
//again, WITH clause is used to access the variables, in this case all the columns from parks_a2.csv
//we will then order that first by descending with the area_in_acres, this area_in_acres = row.`Areas in Acre`
//we can then begin to gather parks that is not the current park, and we will call it nearby_park
//a point consists of latitude and longtitude, to which one point to the other would be the distance
//from the parks, the longtitude and latitude is described as the center point, so we can assume
//that the points are where the parks are located, and the distance between two points will be used for
//point distance calculation, of total distance then we refer that back using the WITH clause after we have
//completed all of our operations and simply return them As a specific name, to top 3 parks with LIMIT clause
```

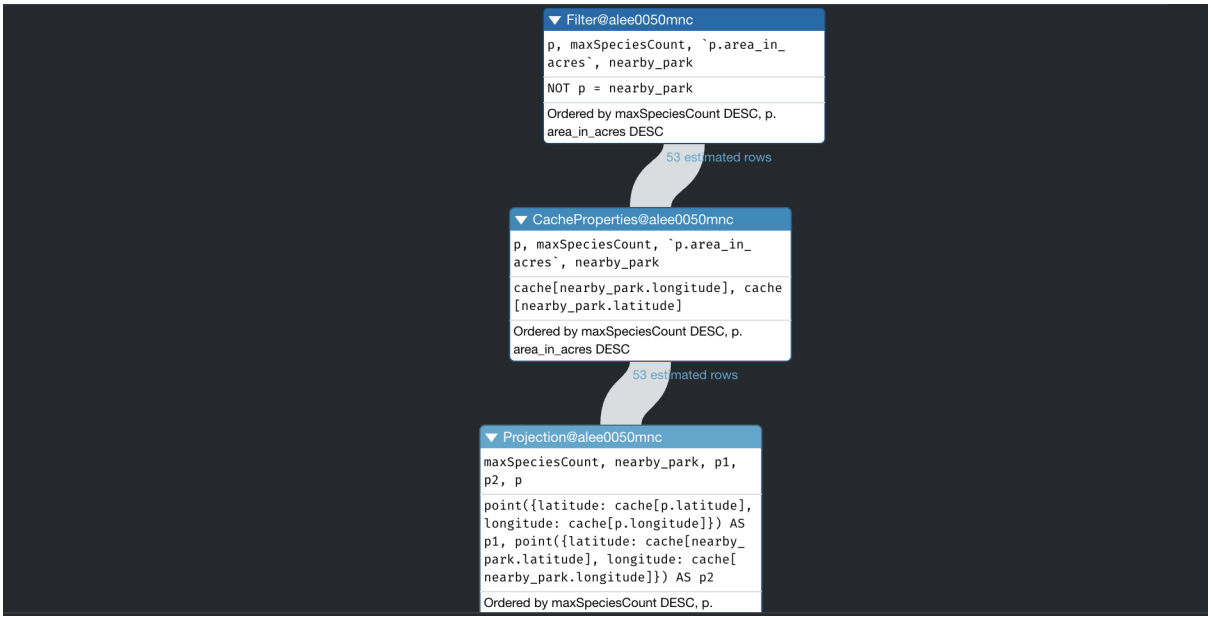
Results:

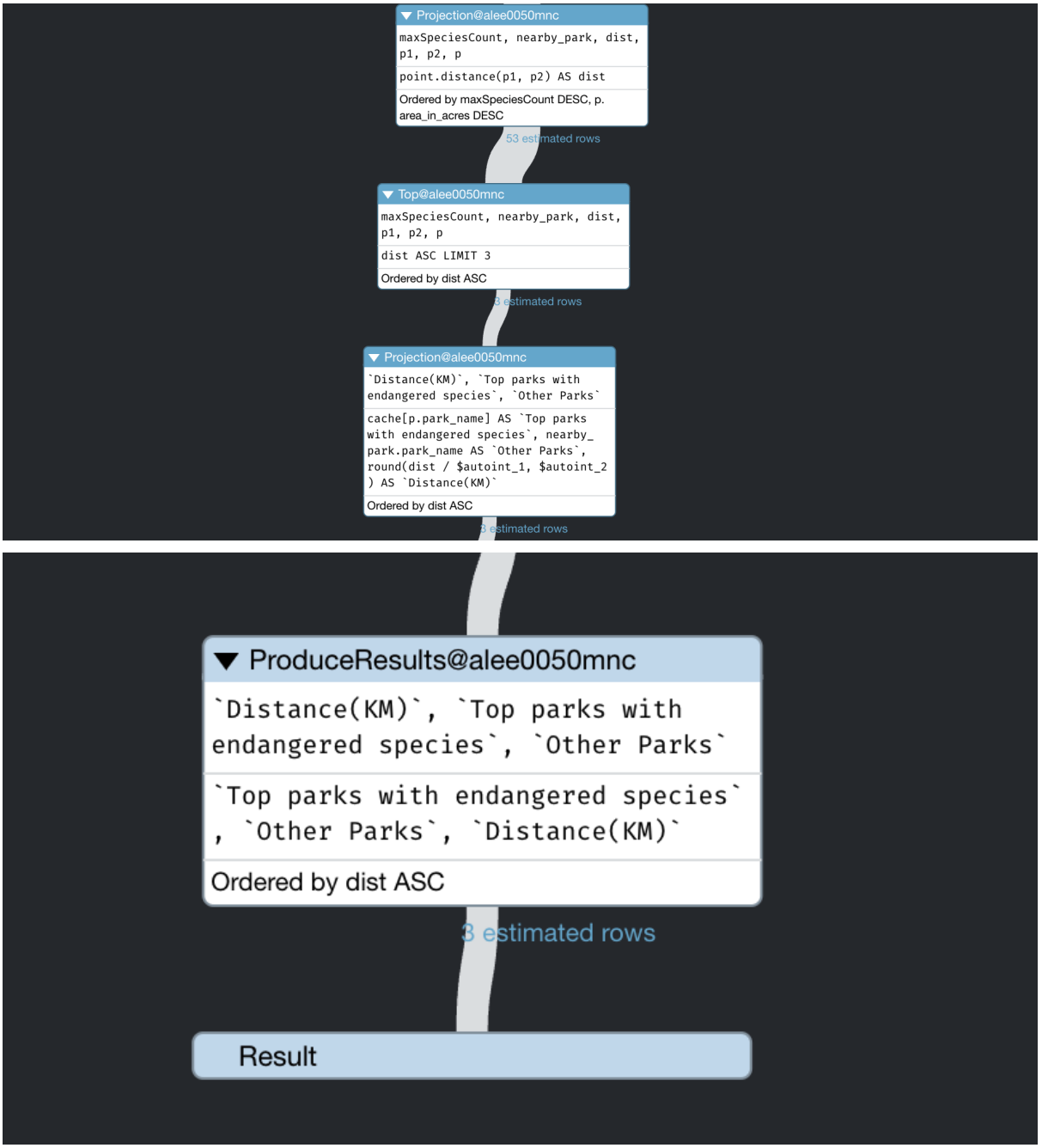


Execution plan:

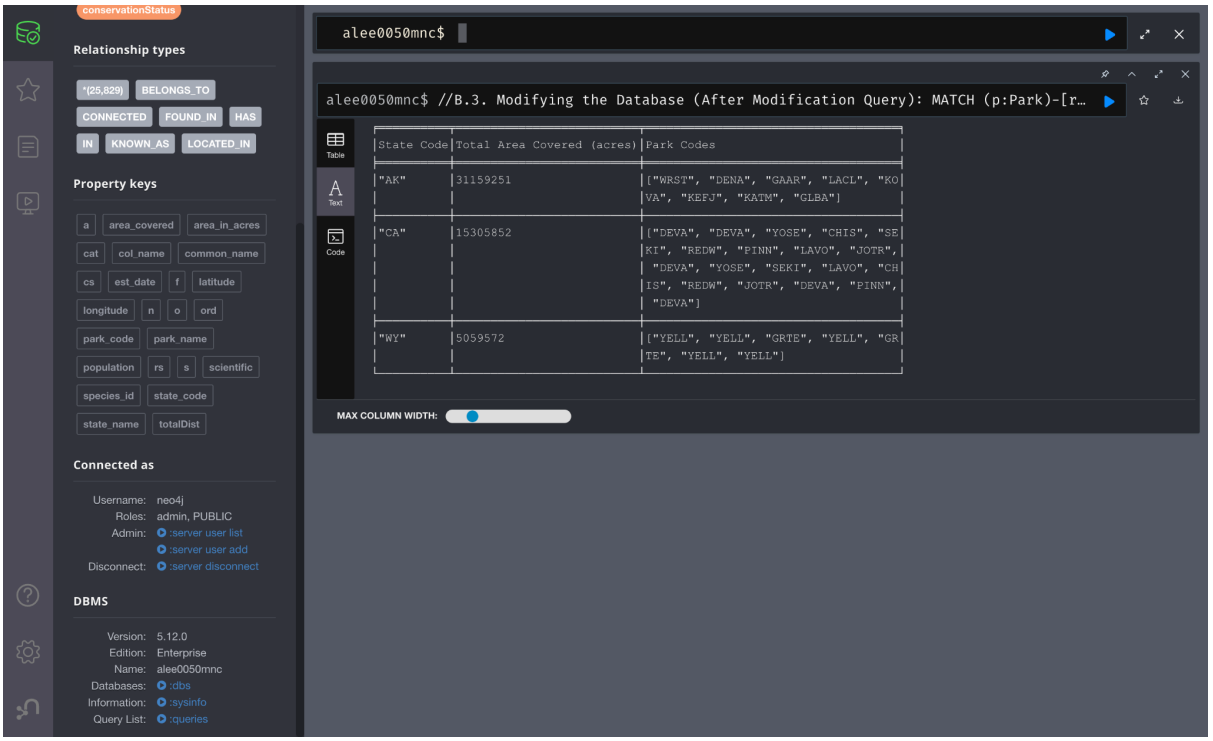

Expand(All)@alee0050mnc
s, f, anon_0, p, c
(s)-[f:FOUND_IN]→(p)
80 estimated rows
Filter@alee0050mnc
s, f, anon_0, p, c
p:Park
80 estimated rows
EagerAggregation@alee0050mnc
p, maxSpeciesCount
p, COUNT(s) AS maxSpeciesCount
9 estimated rows
Projection@alee0050mnc
p, maxSpeciesCount, `p.area_in_acres`
p.area_in_acres AS `p.area_in_acres`
9 estimated rows


Top@alee0050mnc
p, maxSpeciesCount, `p.area_in_acres`
maxSpeciesCount DESC, `p.area_in_acres` DESC LIMIT 1
Ordered by maxSpeciesCount DESC, p.area_in_acres DESC
1 estimated row
CacheProperties@alee0050mnc
p, maxSpeciesCount, `p.area_in_acres`
cache[p.longitude], cache[p.latitude], cache[p.park_name]
Ordered by maxSpeciesCount DESC, p.area_in_acres DESC
1 estimated row
NodeByLabelScan@alee0050mnc
p, maxSpeciesCount, nearby_park
nearby_park:Park
59 estimated rows
Apply@alee0050mnc
p, maxSpeciesCount, `p.area_in_acres`, nearby_park
Ordered by maxSpeciesCount DESC, p.area_in_acres DESC
59 estimated rows


Filter@alee0050mnc
p, maxSpeciesCount, `p.area_in_acres`, nearby_park
NOT p = nearby_park
Ordered by maxSpeciesCount DESC, p.area_in_acres DESC
53 estimated rows
CacheProperties@alee0050mnc
p, maxSpeciesCount, `p.area_in_acres`, nearby_park
cache[nearby_park.longitude], cache[nearby_park.latitude]
Ordered by maxSpeciesCount DESC, p.area_in_acres DESC
53 estimated rows
Projection@alee0050mnc
maxSpeciesCount, nearby_park, p1, p2, p
point({latitude: cache[p.latitude], longitude: cache[p.longitude]}) AS p1, point({latitude: cache[nearby_park.latitude], longitude: cache[nearby_park.longitude]}) AS p2
Ordered by maxSpeciesCount DESC, p.


Projection@alee0050mnc
maxSpeciesCount, nearby_park, dist, p1, p2, p
point.distance(p1, p2) AS dist
Ordered by maxSpeciesCount DESC, p.area_in_acres DESC
53 estimated rows
Top@alee0050mnc
maxSpeciesCount, nearby_park, dist, p1, p2, p
dist ASC LIMIT 3
Ordered by dist ASC
3 estimated rows
Projection@alee0050mnc
`Distance(KM)`, `Top parks with endangered species`, `Other Parks`
cache[p.park_name] AS `Top parks with endangered species`, nearby_park.park_name AS `Other Parks`, round(dist / $autoint_1, $autoint_2) AS `Distance(KM)`
Ordered by dist ASC
3 estimated rows
ProduceResults@alee0050mnc
`Distance(KM)`, `Top parks with endangered species`, `Other Parks`
`Top parks with endangered species`, `Other Parks`, `Distance(KM)`
Ordered by dist ASC
3 estimated rows
Result

B.3. Modifying the Database:



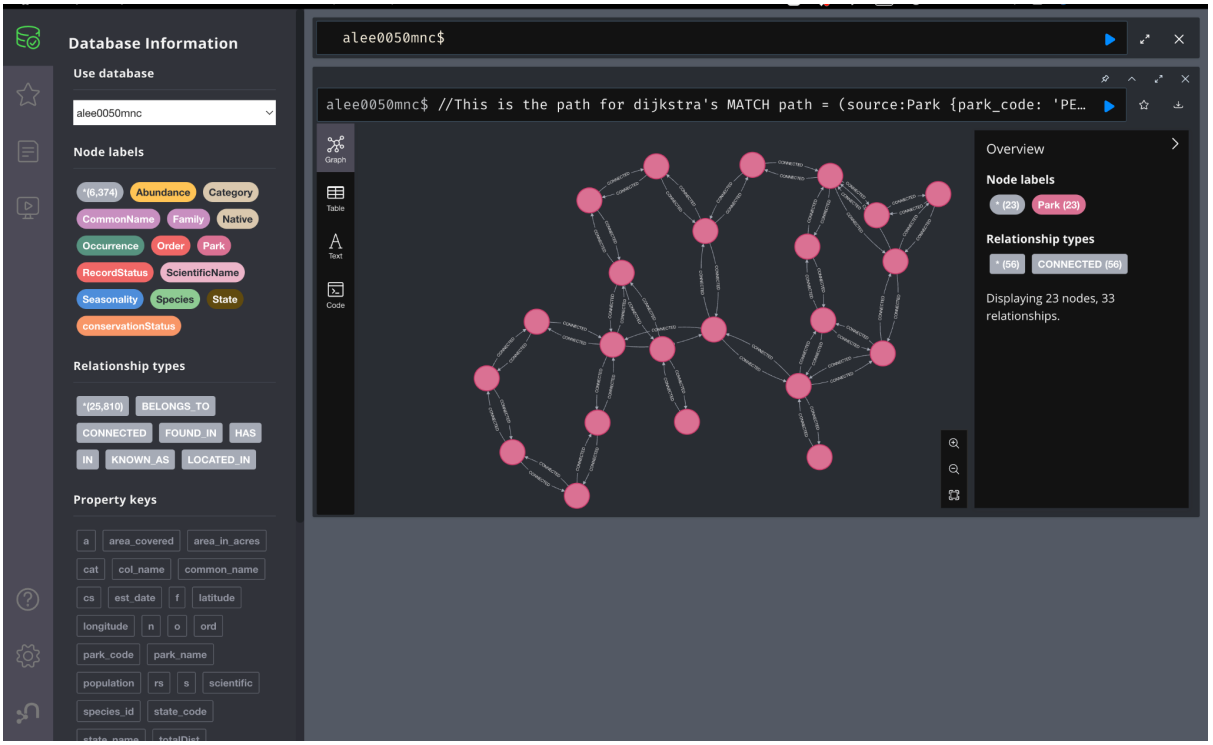
C1: Plugins (Shortest Path A* algorithm)

Code:

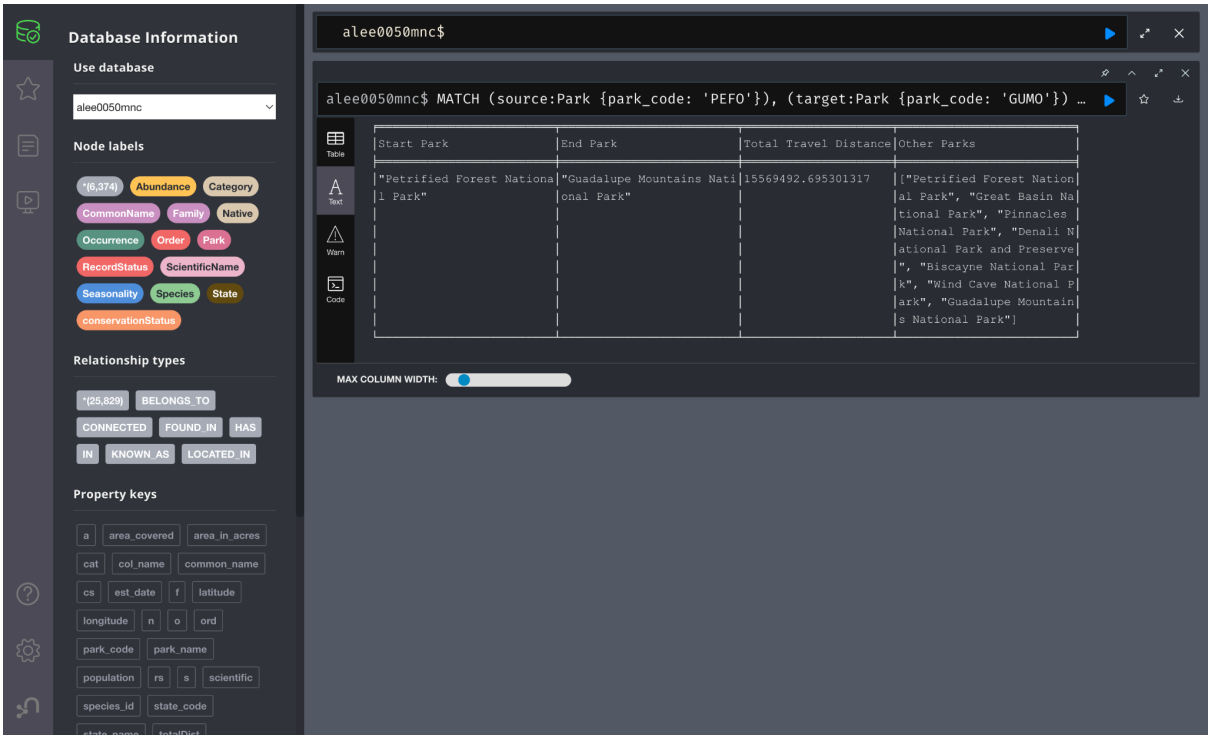
```
LOAD CSV WITH HEADERS FROM "file:///park_connections_a2.csv" AS park_row
MATCH (p:Park {park_code: park_row.`Park Code`}), (nearby_park:Park {park_code: park_row.`Connected Park Code`})
WHERE p.latitude IS NOT NULL AND p.longitude IS NOT NULL AND nearby_park.latitude IS NOT NULL AND nearby_park.longitude IS NOT NULL
WITH p, nearby_park,
    point.distance(
        point({latitude: toFloat(p.latitude), longitude: toFloat(p.longitude)}),
        point({latitude: toFloat(nearby_park.latitude), longitude: toFloat(nearby_park.longitude)})
    ) AS totalDist
MERGE (p)-[:CONNECTED {totalDist: totalDist}]->(nearby_park)
MERGE (nearby_park)-[:CONNECTED {totalDist: totalDist}]->(p);



CALL gds.graph.project(
    'myGraph',
    'Park',
    'CONNECTED',
    {
        relationshipProperties: 'totalDist'
    }
);

MATCH path = (source:Park {park_code: 'PEFO'})-[:CONNECTED*]-(target:Park {park_code: 'GUMO'})
RETURN path LIMIT 1;

MATCH (source:Park {park_code: 'PEFO'}), (target:Park {park_code: 'GUMO'})
CALL gds.shortestPath.dijkstra.stream('myGraph', {
  sourceNode: source,
  targetNode: target,
  relationshipWeightProperty: 'totalDist'
})
YIELD index, sourceNode, targetNode, totalCost, nodeIds, costs, path
UNWIND nodeIds AS nodeId
MATCH (parkNode) WHERE id(parkNode) = nodeId
RETURN
  gds.util.asNode(sourceNode).park_name AS `Start Park`,
  gds.util.asNode(targetNode).park_name AS `End Park`,
  totalCost AS `Total Travel Distance`,
  collect(parkNode.park_name) AS `Other Parks`;
```

Code Explanation:

```
//In order to start with this question, a basic understanding of graph algorithm is required
//we already know that each node is a location in this case it is a park, where vertex is considered the weight
//distance between one node to the other. However, we cannot tranverse from that point if a node is not Connected
//essentially a node has to be connected with another node, and the total distance is necessary for calculation from that one node
//to the other, we have to use point again with point distance.


//we also need to perform a check to see that the longitude and latitude is not null, because of incomplete records.
//we don't need to be extensive about everything not being null because in this case it is just park to park
//then we use totalDist which is the point.distance calculation from current park to nearby_park
//put that in :CONNECTED precisely because we want to calculate the total distance or the vertexes between each node
//from start to end and we will use that later on to calculate the total distance

//we can do a match statement to gain a visualisation of all the possibilities that you can go starting from PEFO to GUMO
//this is before we implement shortestpath dijistra's algorithm
//how dijkstra's algorithm work, it is a greedy algorithm that will always go for the minimum weight to achieve going from one point
//to the other, which makes it very efficient, the complexity of dijkstra's is O(V + ElogV) where V = Vertex and E = Edges
//so it uses a form of priority queue to prioritise min using a heap data structure, we don't need to implement that because our library
//already takes care of it.
//our source node and target node is just start point and end point where totalCost is considered the weight, in this case the Distance
//that it takes to transverse from one point to the other.
//when dijkstra's algorithm is successfully executed, the path is only one because there is only one shortest path, so the path node
//is that one path with minimum distance that it has transversed.
//it also has to be bidirectional so you can come back from endpark to startpark as well
```



Results:



C.2. Neo4j Drivers

Code:

```
41
42  WITH COUNT(s) AS maxSpeciesCount,p
43  ORDER BY maxSpeciesCount DESC, p.area_in_acres DESC LIMIT 1
44
45  MATCH (nearby_park: Park)
46  WHERE p <> nearby_park
47
48  WITH
49      maxSpeciesCount,
50      p,
51      nearby_park,
52      point({latitude: p.latitude, longitude: p.longitude}) AS p1,
53      point({latitude: nearby_park.latitude,longitude: nearby_park.longitude}) AS p2
54
55  WITH p, nearby_park, maxSpeciesCount, point.distance(p1, p2) AS dist
56  ORDER BY dist ASC
57  return p.park_name AS `Top parks with endangered species`, nearby_park.park_name AS `Other Parks`, round(dist/1000,2) AS `Distance(KM)`
58  LIMIT 3;
59  """)
60
61  for record in records:
62      print(record)
63
64  print("\n")
65  print("B3\n")
66
67  #see explanation above.
68  records, summary, keys = driver.execute_query("""
69  MATCH (p:Park)-[r:LOCATED_IN]->(s:State)
70  WITH s.state_code AS `State Code`,
71       SUM(p.area_in_acres) AS `Total Area Covered (acres)`,
72       collect(p.park_code) AS `Park Codes`
73  ORDER BY `Total Area Covered (acres)` DESC
74  RETURN `State Code`, `Total Area Covered (acres)`, `Park Codes`
75  LIMIT 3;
76  """)
77
78  for record in records:
79      print(record)
```

Results:

```python
from neo4j import GraphDatabase

#this is the connection port of which the server access is obtained through :SERVER STATUS
URI = "bolt://localhost:7689"
#credentials, as we are using the default user neo4j <username> and Pta59ypt123 <password>
AUTH = ("neo4j", "Pta59ypt123")
driver = GraphDatabase.driver(URI, auth=AUTH)
#this is initializing the driver object using neo4j import


#simple print statement to indicate which question it is
print("B1\n")

#using the to be fair we only need records, but this is saved for future implementation where a developer would want to measure
#the efficiency through summary and the keys is just used to return default object
records, summary, keys = driver.execute_query("""
// MATCH all the species with the relationship known_as
MATCH (s:Species)-[r:KNOWN_AS]->(c:CommonName)
// match species found_in park relationship
MATCH (s)-[f:FOUND_IN]->(p:Park)
// common name should contain Coyote
WHERE c.common_name CONTAINS 'Coyote'

WITH p, c.common_name AS comName, SUM(f.population) AS tot
// Filter out single names by checking for the existence of a comma
WHERE comName CONTAINS ','
RETURN p.park_name AS `Park Name`, collect(comName) AS `Coyote Species`, tot AS `Coyote Population`
ORDER BY tot DESC;
    """
)
#this is just used to print all the records
for record in records:
    print(record)

print("\n")
print("B2\n")

#this is repetitive, see explanation above
records, summary, keys = driver.execute_query("""MATCH (s:Species)-[:HAS]->(c:conservationStatus{cs:"Endangered"})
MATCH (s)-[f:FOUND_IN]->(p:Park)

WITH COUNT(s) AS maxSpeciesCount,p
```