Phase IV
Elaboration: Database Design
Group 7
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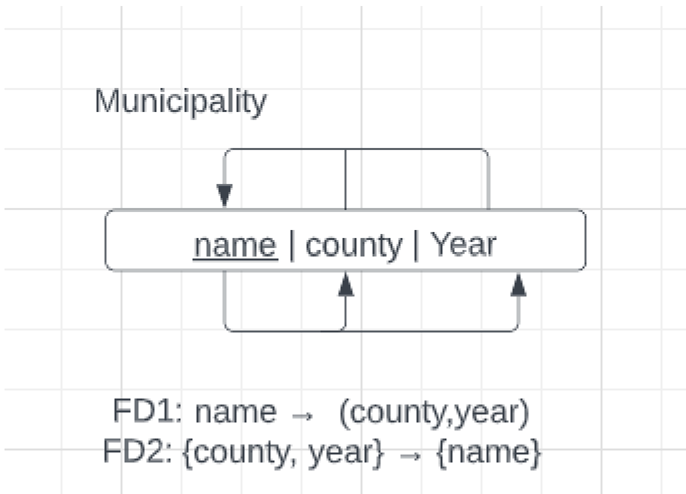
Demonstrate that all the relations in the relational schema are normalized to Boyce–Codd normal form (BCNF).

a.

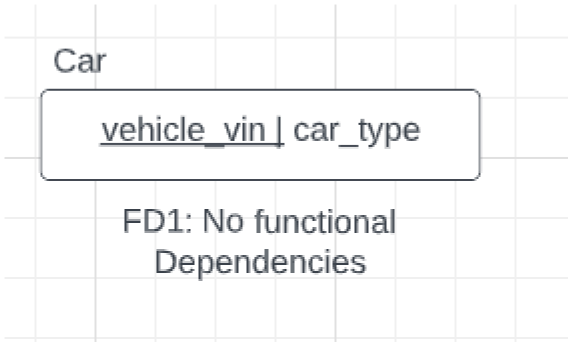


This relation is normalized to 1NF, 2NF and 3nf. In order to normalize this Relation to BCNF we need to make sure that every non-trivial functional dependency in the relation has a determinant that is a superkey of the relation. In the "Municipal" relation, the only non-trivial functional dependency is {name} → {county, year}, however {name} is not a superkey of the relation. In order to make the "Municipal" relation into BCNF, we need to break it down further:

R1(name, county)

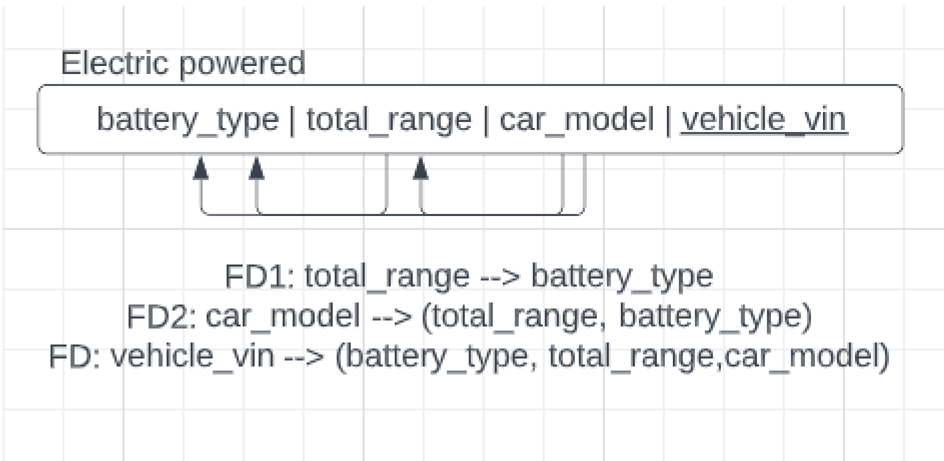
R2(name, year, county)

In this decomposition, R1 has a candidate key {name}, and R2 has a candidate key {name, year}. The functional dependency {name} → {county, year} is now represented in both R1 and R2, ensuring that every non-trivial functional dependency has a determinant that is a candidate key.



b. This relation has no functional dependencies and therefore cannot be broken down into BCNF.

c.



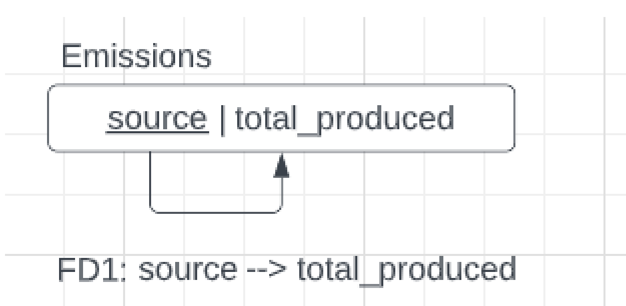
This relation is already in 1NF and 2NF but not in 3NF, in order to normalize this relation in 3NF, we must remove the transitive dependencies. {car_model} → {battery_type, total_range} is a transitive dependency which can be broken down into

R1: (vehicle_vin, car_model,total_range)

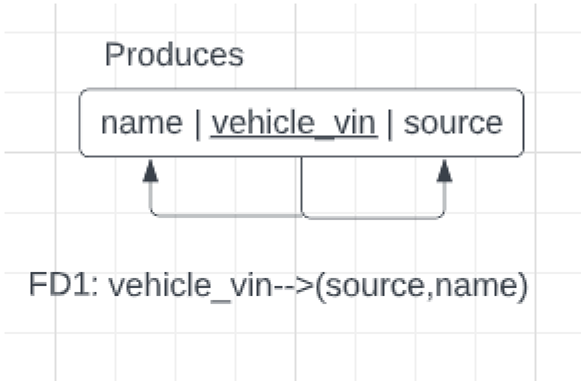
R2: (battery_type, total_range)

Since In each relation, every determinant is a candidate key, and there are no non-trivial functional dependencies among non-key attributes. Therefore, both relations satisfy the definition of BCNF.

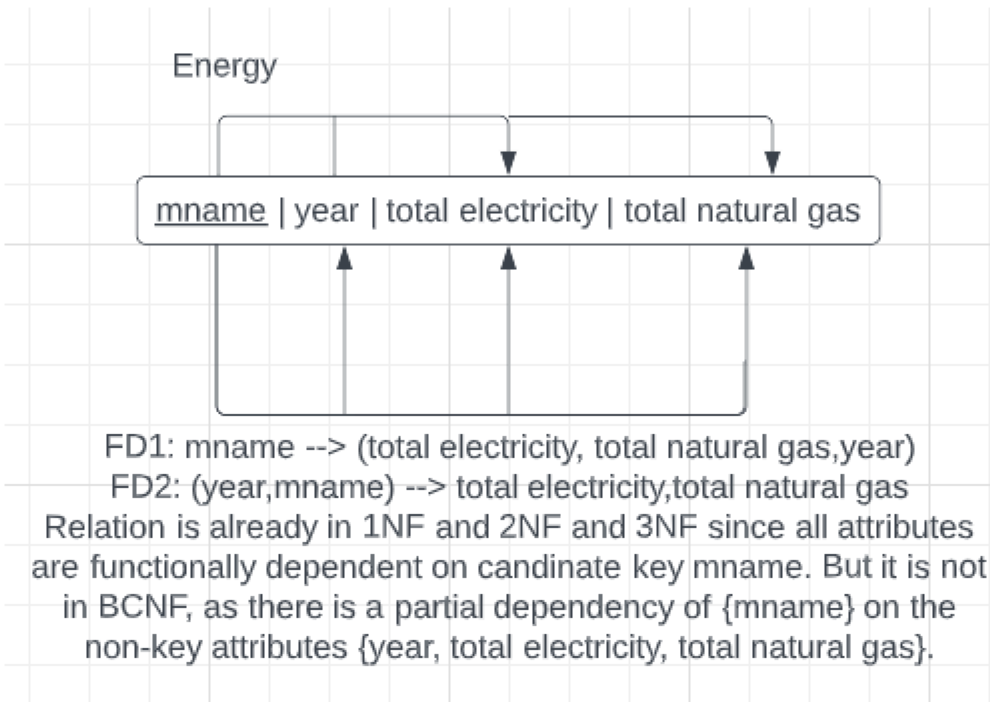
d.



Since there is only one candidate key, which is the primary key {total_produced}, and there are no non-trivial functional dependencies in the relation meaning the relation is already in BCNF.



e. Since the "Produces" relation has only one functional dependency: {vehicle_vin} → {source, name}, and the primary key {vehicle_vin} determines all other attributes in the relation, the relation is already in BCNF.



f. To bring the "Energy" relation to BCNF, we can decompose it into two smaller relations:

R1: (mname, year, total electricity)
R2:(mname, year, total natural gas)
Both of these relations have candidate keys {mname, year}. By breaking down the relation into these two smaller relations, we make sure that there are no partial dependencies, and each relation has a single candidate key.The relation is now in BCNF

Define the different views (virtual tables) required. For each view list the data and transaction requirements. Give a few examples of queries, in English, to illustrate.

- We could just do 2 here – don't have to do all

- List the emissions produced for all cars
  CREATE VIEW EmissionsForAllCars AS
  SELECT E.total_produced
  FROM Emissions E
  CROSS JOIN Car
  WHERE Car.car_type = 'gas powered' AND 'electric powered'

- List how much electricity do cars alone produce in each municipality
  CREATE VIEW ElectricityProducedInEachMunicipality AS
  SELECT EY.total_electricty, M.mname
  FROM Energy EY
  JOIN Municipality M ON M.mname = EY.mname
  CROSS JOIN Car
  WHERE Car.car_type = electric powered'

Design a complete set of SQL queries to satisfy the transaction requirements identified in the previous stages, using the relational schema and views defined in tasks 2 and 3 above.

1. **Which type of car generates the most amount of emissions?**
   SELECT C.car_type, Emissions.total_produced
   FROM Car C
   CROSS JOIN Emissions
   WHERE Car.car_type = 'gas powered' AND 'electric powered'

2. **Which municipality generates the most amount of emissions?**
   SELECT M.name, MAX(Emissions.total_produced)
   FROM Municipality M
   CROSS JOIN Emissions

3. **Which county generates generates the most amount of emissions?**

```
SELECT M.name, Emissions.total_produced
FROM Municipality M
CROSS JOIN Emissions
```

4. Which electric car model generates the most amount of emissions?

5. Which gas car model generates the most amount of emissions?
6. **From cars alone how much electricity does each municipality consume?**

```
SELECT EY.total_electricty, M.mname
FROM Energy EY
JOIN Municipality M ON M.mname = EY.mname
CROSS JOIN Car
WHERE Car.car_type = electric powered’
```

7. From cars alone how much natural gas does each municipality consume?
8. Which source generates the most amount of emissions?
9. Which year generated the most emissions in each municipality?