Eden Espinosa, Kristen O'Donnell, Owen Greaney

Professor DeGood

CSC 315 - 01

April 10, 2023

Phase IV Elaboration: Database Design

1. **Demonstrate that all the relations in the relational schema are normalized to Boyce-Codd normal form (BCNF).**

1 NF

Area_Info

Municipality	County

Gas_Vehicles

Municipality	Year	Passenger_Cars	Total_Miles	Total_Emissions

Electric_Vehicles

Municipality	Year	Total_Personal_Vehicles	#_of_EVs

Energy_Emissions

Municipality	Year	Residential_Electricity_EE	Residential_Natural_Gas_EE	Total_Electricity	Total_Natural_Gases

Greenhouse_Gases

Municipality	Year	Residential_Electricity_GHG	Residential_Natural_Gas_GHG	On_Road_Vehicles	Total_MTCO2e

This is already in 1NF because all the attributes have singular values.

2 NF

Area_Info

Municipality	County

Gas_Vehicles

Municipality	Year	Passenger_Cars	Total_Miles	Total_Emissions

Electric_Vehicles

Municipality	Year	Total_Personal_Vehicles	#_of_EVs

Energy_Emissions

Municipality	Year	Residential_Electricity_EE	Residential_Natural_Gas_EE	Total_Electricity	Total_Natural_Gases

Greenhouse_Gases

Municipality	Year	Residential_Electricity_GHG	Residential_Natural_Gas_GHG	On_Road_Vehicles	Total_MTCO2e

Since no attributes are unique if the composite keys are separated, this is already in 2NF.

3 NF

Area_Info

Municipality	County

Gas_Vehicles

Municipality	Year	Passenger_Cars	Total_Miles	Total_Emissions

Electric_Vehicles

Municipality	Year	Total_Personal_Vehicles	#_of_EVs

Energy_Emissions

Municipality	Year	Residential_Electricity_EE	Residential_Natural_Gas_EE	Total_Electricity	Total_Natural_Gases

Greenhouse_Gases

Municipality	Year	Residential_Electricity_GHG	Residential_Natural_Gas_GHG	On_Road_Vehicles	Total_MTCO2e

Since no attributes are uniquely defined by other attributes, this is in 3NF.

BCNF

Area_Info

Municipality	County

Gas_Vehicles

Municipality	Year	Passenger_Cars	Total_Miles	Total_Emissions

Electric_Vehicles

Municipality	Year	Total_Personal_Vehicles	#_of_EVs

Energy_Emissions

Municipality	Year	Residential_Electricity_EE	Residential_Natural_Gas_EE	Total_Electricity	Total_Natural_Gases

Greenhouse_Gases

Municipality	Year	Residential_Electricity_GHG	Residential_Natural_Gas_GHG	On_Road_Vehicles	Total_MTCO2e

Since there are no colliding candidate keys and it is already in 3NF, this is also in BCNF.

2. **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.**

CREATE VIEW Area AS

SELECT Municipality, County

FROM Area_Info;

Example: SELECT * FROM Area : retrieves all municipalities and counties from Area_Info

Transaction Requirements:

Atomicity: this command is atomic because it cannot be done partially.

Consistency: the command is only selecting from the view and is not changing the data itself, making it consistent

Isolation: this command is done alone and is not affected by other transactions

Durability: the command SELECT does not apply changes to the database

CREATE VIEW GVs AS

SELECT Municipality, Year, Passenger_Cars, Total_Miles, Total_Emissions

FROM Gas_Vehicles;

Example: SELECT Total_Miles

FROM GVs

WHERE Municipality = ‘Trenton City’ AND Year = ‘2019’;

- This selects the total vehicle miles traveled in Trenton City in 2019

Transaction Requirements:

Atomicity: this transaction is atomic because it is completed in full

Consistency: this transaction does not change the data in the database, therefore the data is in a consistent state before and after the transaction

Isolation: this transaction does not interfere with the other transactions that may occur at the same time

Durability: the SELECT command does not make permanent modifications to the database

```
CREATE VIEW EVs AS
SELECT Municipality, Year, Total_Passenger_Vehicles, #_of_EVs
FROM Electric_Vehicles;

CREATE VIEW Energy AS
SELECT Municipality, Year, Residential_Electricity_EE, Residential_Natural_Gas_EE,
Total_Electricity, Total_Natural_Gases
FROM Energy_Emissions;

CREATE VIEW Gas AS
SELECT Municipality, Year, Residential_Electricity_GHG, Residential_Natural_Gas_GHG,
On_Road_Vehicles, Total_MTCO2e
FROM Greenhouse_Gases;
```

3. **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.) Retrieve the total number of personal vehicles in the year 2020 in Egg Harbor township.

```
SELECT Total_Personal_Vehicles
FROM EVs
WHERE Municipality = ‘Egg Harbor township’ AND Year = ‘2020’;
```

2.) For each municipality, list the total electricity and metric tons of carbon dioxide in 2015.

```
SELECT Municipality, Total_Electricity, Total_MTCO2e
FROM Energy NATURAL JOIN Gas
WHERE Year = ‘2015’;
```

3.) Retrieve the total miles traveled in Mercer county.

```
SELECT SUM(Total_Miles)
FROM Area NATURAL JOIN GVs
WHERE County = ‘Mercer’;
```

Because these queries used each relation once, this is a complete set.