Database
420-921-VA
Vanier College

CAR2GO Project

Car Rental Database System

Submitted by:
Md Ibrahim Ullah, ID: 2295025
Mark Benedict Muyot, ID: 2295022

Submitted to:
Prof. Jaina Sheth

June 23, 2022

TABLE OF CONTENTS

INTRODUCTION

The project is all about creating a database system for Car2go company. This database system will help the company to accommodate and organize large volume of data in an effective, secured, and accurate manner. Tools such as SQL Management studios, Azure data studios, etc. will be used together with the concepts and learnings acquired during database class will be implemented and put in to work into this project.

The first section provides introduction of the project, followed by the teamwork contribution. For the next section we will be stating the project scenario together with the business rules and assumptions. Then the conceptual and logical design of the database in its normalized form will be shown. A listing of attributes and constraints is provided for each database table in the database including screenshots of records.

End section provides challenges and improvements together with our conclusion, future work, and references used for this project.

TEAMWORK DISTRIBUTION

Tasks	**Done by**
Writing Description, D1	Md Ibrahim Ullah, Mark Benedict Muyot
Listing down business rules and assumptions, D1	Md Ibrahim Ullah, Mark Benedict Muyot
Conceptual Design, D1	Md Ibrahim Ullah, Mark Benedict Muyot
Logical Design, D1	Md Ibrahim Ullah, Mark Benedict Muyot
Normalization, D1	Md Ibrahim Ullah Mark Benedict Muyot
Editing Finalized Conceptual & logical design after correction, D1	Md Ibrahim Ullah Mark Benedict Muyot
DDL and DML, D2	Md Ibrahim Ullah Mark Benedict Muyot
Finalized DDL and DML , D2	Md Ibrahim Ullah Mark Benedict Muyot
Queries and Script, D3	Md Ibrahim Ullah Mark Benedict Muyot
Project Report, D3	Md Ibrahim Ullah Mark Benedict Muyot

SCENARIO DESCRIPTION

Car2go is a car rental company that provides vehicle rental to customers for specific period of time. They have variety of cars to choose from depending on what type or class is suited for the customer. The customer can choose a subcompact, compact, sedan or a luxury car depending on the need and preference.
The company has several branch locations which allows customer to rent a vehicle from one location and can be dropped off to another Car2go branch. They operate also at rural areas which provides accessibility to customers.
The company's pricing is based on the type of the car and the duration of the rental. They also offer promotional rentals and gives discounts for certain weeks.

Business rules and assumptions:

Business rules:

- The company has several locations with different addresses.
    - Addresses include:
        - street / rural route address which includes:
            - street / rural route number
            - street / rural route name
        - city
        - province
        - postal code

- The company classified the car options as subcompacts, compacts, sedans, or luxury. Each car has a specific year, make, model, and color, and has both unique identification number and license plate.

- A car can be rented in a particular location but possible to be returned in a different location (drop-off location).

- The company keeps track of odometer readings and gas volume before and after the car renting, but always rent with full tank of gas and only indicate if the tank is empty, quarter full, half full, three quarters full, or full at the time of returning.

- The company tracks the rental and return dates.

- Each customer can choose a preferable class of car and can rent only one at a time. Customers may get a free upgrade if the requested class of car is not available, at the same price as the earlier requested class.

- Prices are different for each class of cars, but all cars in the same class are priced the same. prices are calculated based on a car class and each day of rental.

- Final invoice (drop-off charge) will be calculated on the class of the rental car and total number of rental days (rented date to returned date, minimum is 1), and any applicable promotion.

- The company keeps records of each customer's name, mailing address, phone number(s) (if there are any), email addresses (if there are any), and a unique driver's license number.
    - Name includes:
        - first name
        - last name
    - Mailing address:
        - street address which includes:
            - street number
            - street name
            - apartment / unit number (if has any).
        - city
        - Province / state
        - Postal code
        - Country
    - Phone number(s) (if has any) which includes:
        - country code
        - area code
        - local number
    - Email address(es)

      Email has only one string and no structure is assumed.
- The company has 50% promotional rentals on certain weeks in the year, but maybe also of different percentage. The promotions always affect only a single class of car at a time.

Assumptions:

- Customers can cancel reservations for a certain window of time and can incur some penalties when that window lapsed.

- Customers should be of legal age and have a valid driver's license to be able to rent a car.

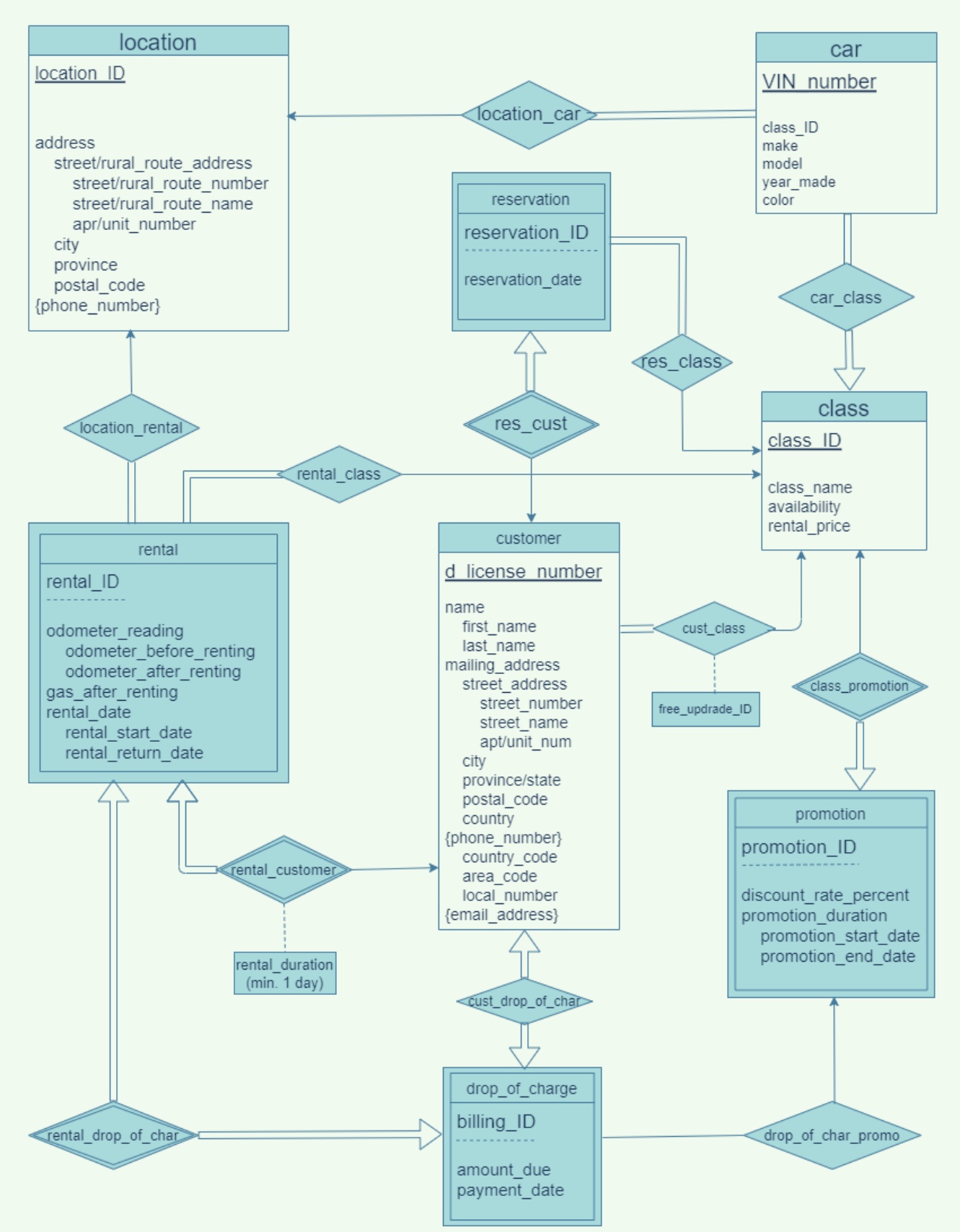
- The company will set mileage limits and will charge the customer for extra miles traveled.

- Customers should return the car in full tank, or an option to pay the gas usage.

- Once the car is returned it will be available again in the system.

- An additional fee will be charged if the car is returned after the set returned date, however earlier return will be available.

Conceptual Design of the database: ERD (Entity Relationship Diagram)

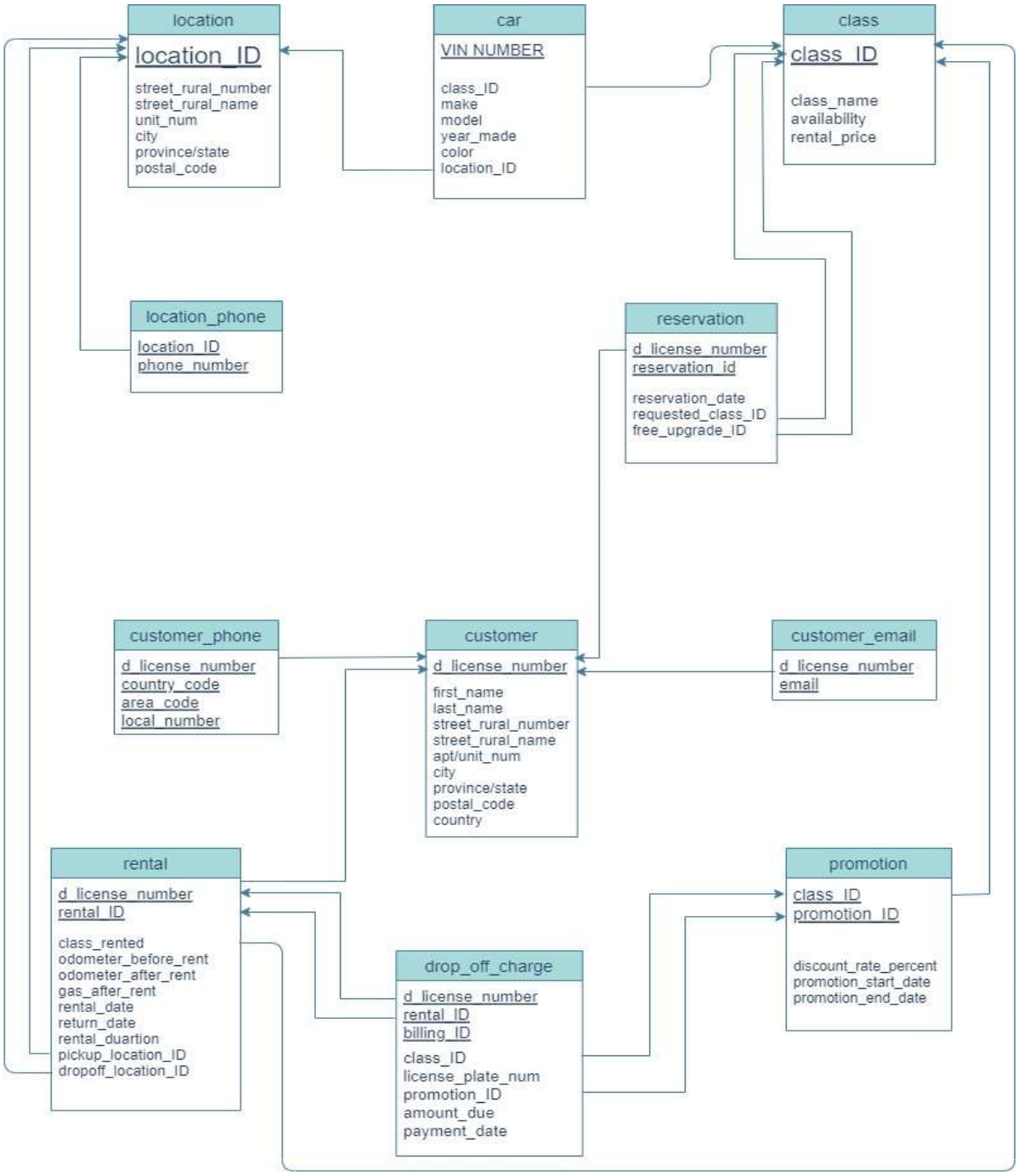

location
location_ID
address
street/rural_route_address
street/rural_route_number
street/rural_route_name
apr/unit_number
city
province
postal_code
{phone_number}
location_car
car
VIN_number
class_ID
make
model
year_made
color
reservation
reservation_ID
reservation_date
car_class
res_class
location_rental
res_cust
class
class_ID
class_name
availability
rental_price
rental_class
rental
rental_ID
odometer_reading
odometer_before_renting
odometer_after_renting
gas_after_renting
rental_date
rental_start_date
rental_return_date
customer
d_license_number
name
first_name
last_name
mailing_address
street_address
street_number
street_name
apt/unit_num
city
province/state
postal_code
country
{phone_number}
country_code
area_code
local_number
{email_address}
cust_class
free_updrade_ID
class_promotion
promotion
promotion_ID
discount_rate_percent
promotion_duration
promotion_start_date
promotion_end_date
rental_customer
rental_duration
(min. 1 day)
cust_drop_of_char
drop_of_charge
billing_ID
amount_due
payment_date
rental_drop_of_char
drop_of_char_promo

Relationship table involving entities with relationship levels and connectivity:

Entity	Relation with	Relationship name	Relationship levels	Connectivity
location	**car**	**location_car**	**Binary (Degree of 2)**	**One to Many**
location	**rental**	**location_rental**	**Binary (Degree of 2)**	**One to Many**
car	**class**	**car_class**	**Binary (Degree of 2)**	**Many to One**
reservation	**class**	**res_class**	**Binary (Degree of 2)**	**Many to One**
reservation	**customer**	**res_cust**	**Binary (Degree of 2)**	**One to One**
rental	**class**	**rental_class**	**Binary (Degree of 2)**	**Many to One**
rental	**customer**	**rental_customer**	**Binary (Degree of 2)**	**One to One**
customer	**class**	**cust_class**	**Binary (Degree of 2)**	**Many to One**
class	**promotion**	**class_promotion**	**Binary (Degree of 2)**	**One to One**
drop_off_ charge	**promotion**	**drop_of_char_ promo**	**Binary (Degree of 2)**	**Many to One**
customer	**drop_off_ charge**	**cust_drop_off_char**	**Binary (Degree of 2)**	**One to One**
rental	**drop_off_ charge**	**rental_drop_off_ char**	**Binary (Degree of 2)**	**One to One**

LOGICAL DESIGN SCHEMA:

Logical schema diagram



FUNCTIONAL DEPENDENCIES & DATABASE NORMALIZATION

Full Functional Dependency

Customer
d_license_number --> (first_name, last_name, street_rural_number, street_rural_name, apt/unit_num, city, province/state, postal_code, country)

Location
Location_ID --> (street_rural_number, street_rural_name, unit_num, city, province/state, postal_code)

Car
VIN_NUMBER --> (class_ID, make, model, year_made, color, location_ID)

Class
Class_ID --> (class_name, availability, rental_price)

Reservation
(d_license_number, reservation_ID) --> (reservation_date, requested_class_ID, free_upgrade_ID)

Rental
(d_license_number, rental_ID) --> (class_rented, odometer_before_rent, odometer_after_rent, gas_after_rent, rental_date, return_date, rental_duration, pickup_location_ID, dropoff_location_ID)

Drop_off_charge
(d_license_number, rental_ID, billing_ID) --> (amount_due, payment_date, class_ID, promotion_ID, license_plate_number)

Promotion
(class_ID, Promotion_ID) --> (discount_rate, promotion_start_date, promotion_end_date)

Trivial Functional Dependency:

Location_phone
(Location_ID, phone_number) --> phone_number

Customer_phone
(Drivers_license_number, country_code, area_code,local_number) --> (country_code, area_code,local_number)

Customer_email
(Drivers_license_number, email) --> email

Database Normalization

No Normalization was performed. All tables are in 1NF/2NF/3NF.

DATABASE TABLES

Table Name	Attrributes	Data Type	NULL	CONSTRAINTS
LOCATION	LOCATION_ID	INT	NOT NULL	PRIMARY KEY
	STREET_RURAL_NUMBER	INT	NOT NULL	
	STREET_RURAL_NAME	VARCHAR(40)	NOT NULL	
	UNIT_NUM	VARCHAR(10)	NULL	
	CITY	VARCHAR(50)	NOT NULL	
	PROVINCIAL_STATE	VARCHAR(50)	NOT NULL	
	POSTAL_CODE	VARCHAR(10)	NOT NULL	CHECK

	LOCATION_ID	STREET_RURAL_NUMBER	STREET_RURAL_NAME	UNIT_NUM	CITY	PROVINCE_STATE	POSTAL_CODE
1	1	100	ST_CATHERINE E	NULL	MONTREAL	QC	A1B 2C2
2	2	200	MAISONNEUVE O	NULL	MONTREAL	QC	A2B 3D2
3	3	1005	SHERBROOK O	A	MONTREAL	QC	E4B 3R5
4	4	1000	MARINE DRIVE	NULL	LAVAL	QC	C7T 2Y6
5	5	3000	BOUL TASCHEREAU	NULL	BROSSARD	QC	A1S 4U8

Table Name	Attrributes	Data Type	NULL	CONSTRAINTS
LOCATION_PHONE	LOCATION_ID	INT	NOT NULL	PRIMARY KEY/FORERIGN KEY
	PHONE_NUMBER	VARCHAR(15)	NOT NULL	PRIMARY KEY

	LOCATION_ID	PHONE_NUMBER
1	1	514-1002222
2	1	514-2003333
3	2	514-3004444
4	3	514-4005555
5	4	450-1001234

Table Name	Attrributes	Data Type	NULL	CONSTRAINTS
CLASS	CLASS_ID	INT	NOT NULL	PRIMARY KEY
	CLASS_NAME	VARCHAR(30)	NOT NULL	
	AVAILABILITY	VARCHAR(5)	NOT NULL	
	RENTAL_PRICE	MONEY	NOT NULL	

	CLASS_ID	CLASS_NAME	AVAILABILITY	RENTAL_PRICE
1	1	SUBCOMPACTS	YES	70.00
2	2	COMPACTS	YES	90.00
3	3	SEDANS	YES	110.00
4	4	LUXURY	YES	130.00

Table Name	Attrributes	Data Type	NULL	CONSTRAINTS
CAR	VIN_NUMBER	VARCHAR(30)	NOT NULL	PRIMARY KEY
	CLASS_ID	INT	NOT NULL	FOREIGN KEY
	MAKE	VARCHAR(20)	NOT NULL	
	MODEL	VARCHAR(20)	NOT NULL	
	YEAR_MADE	INT	NOT NULL	
	COLOR	VARCHAR(15)	NULL	
	LOCATION_ID	INT	NULL	FOREIGN KEY

	VIN_NUMBER	CLASS_ID	MAKE	MODEL	YEAR_MADE	COLOR	LOCATION_ID
1	A1234407889	1	NISSAN	MICRA	2022	WHITE	2
2	B2367189625	2	TOYOTA	COROLLA	2022	RED	3
3	C3456213458	3	TOYOTA	HIGHLANDER	2021	GREY	4
4	D4566781230	4	BMW	X7	2022	BLACK	5
5	E7638290732	2	HONDA	ACCORD	2021	BLUE	1

Table Name	Attrributes	Data Type	NULL	CONSTRAINTS
CUSTOMER	D_LICENSE_NUMBER	VARCHAR(30)	NOT NULL	PRIMARY KEY/CHECK
	FIRST_NAME	VARCHAR(40)	NOT NULL	
	LAST_NAME	VARCHAR(40)	NOT NULL	
	STREET_RURAL_NUMBER	VARCHAR(10)	NOT NULL	
	STREET_RURAL_NAME	VARCHAR(20)	NOT NULL	
	APT_UNIT_NUM	VARCHAR(10)	NULL	
	CITY	VARCHAR(20)	NOT NULL	
	PROVINCE_STATE	VARCHAR(20)	NOT NULL	DEFAULT
	POSTAL_CODE	VARCHAR(15)	NOT NULL	
	COUNTRY	VARCHAR(20)	NOT NULL	DEFAULT

	D_LICENSE_NUMBER	FIRST_NAME	LAST_NAME	STREET_RURAL_NUMBER	STREET_RURAL_NAME	APT_UNIT_NUM	CITY	PROVINCE_STATE	POSTAL_CODE	COUNTRY
1	C4006-011075-12	JOHN	CARTER	45	ADEL	4	MONTREAL	QUEBEC	H3K 2Y2	CANADA
2	C6018-311299-37	JAMES	COBELT	440	MAIN	NULL	WINDSOR	PEI	U8J 3S6	CANADA
3	F4172-100995-06	HENRI	FORD	450	LAKE SHORE	NULL	LONDON	ONTARIO	K9O 0L1	CANADA
4	G3002-041189-11	DAVID	GOYER	23	BISHOP	2	LAVAL	QUEBEC	J4E 7Y3	CANADA

Table Name	Attrributes	Data Type	NULL	CONSTRAINTS
RESERVATION	D_LICENSE_NUMBER	VARCHAR(30)	NOT NULL	PRIMARY/ FOREIGN KEY/CHECK

	RESERVATION_ID	INT	NOT NULL	PRIMARY KEY
	RESERVATION_DATE	DATE	NOT NULL	
	REQUESTED_CLASS_ID	INT	NOT NULL	FOREIGN KEY
	FREE_UPGRADE_ID	INT	NOT NULL	FOREIGN KEY

	D_LICENSE_NUMBER	RESERVATION_ID	RESERVATION_DATE	REQUESTED_CLASS_ID	FREE_UPGRADE_ID
1	C4006-011075-12	1	2022-06-18	1	NULL
2	C6018-311299-37	4	2022-01-20	2	NULL
3	F4172-100995-06	3	2021-06-25	4	NULL
4	G3002-041189-11	2	2022-06-18	3	NULL

Table Name	Attrributes	Data Type	NULL	CONSTRAINTS
CUSTOMER_PHONE	D_LICENSE_NUMBER	VARCHAR(30)	NOT NULL	PRIMARY/ FOREIGN KEY/CHECK
	COUNTRY_CODE	INT	NOT NULL	PRIMARY KEY/ DEFAULT
	AREA_CODE	INT	NOT NULL	PRIMARY KEY
	LOCAL_NUMBER	INT	NOT NULL	PRIMARY KEY

	D_LICENSE_NUMBER	COUNTRY_CODE	AREA_CODE	LOCAL_NUMBER
1	C4006-011075-12	1	514	9314410
2	C4006-011075-12	1	514	9314430
3	C6018-311299-37	1	819	1725500
4	C6018-311299-37	1	819	1725508
5	F4172-100995-06	1	416	3578901

Table Name	Attrributes	Data Type	NULL	CONSTRAINTS
CUSTOMER_EMAIL	D_LICENSE_NUMBER	VARCHAR(30)	NOT NULL	PRIMARY/ FOREIGN KEY/CHECK
	EMAIL	VARCHAR(50)	NOT NULL	PRIMARY KEY

	D_LICENSE_NUMBER	EMAIL
1	C4006-011075-12	JOHNC@GMAIL.COM
2	C4006-011075-12	JOHNC2@YAHOO.COM
3	C6018-311299-37	JAMES_C1@YAHOO.COM
4	C6018-311299-37	JAMES_C2@GMAIL.COM
5	F4172-100995-06	FORDH@HOTMAIL.COM

Table Name	Attrributes	Data Type	NULL	CONSTRAINTS
RENTAL	D_LICENSE_NUMBER	VARCHAR(30)	NOT NULL	PRIMARY/ FOREIGN KEY/CHECK
	RENTAL_ID	INT	NOT NULL	PRIMARY KEY
	CLASS_RENTED	INT	NOT NULL	FOREIGN KEY
	ODOMETER_BEFORE_RENT	INT	NOT NULL	
	ODOMETER_AFTER_RENT	INT	NOT NULL	
	GAS_AFTER_RENT	VARCHAR(30)	NOT NULL	
	RENTAL_DATE	DATE	NOT NULL	
	RETURN_DATE	DATE	NOT NULL	
	RENTAL_DURATION	INT	NULL NULL	DEFAULT
	PICKUP_LOCATION_ID	INT	NOT_NULL	FOREIGN KEY
	DROPOFF_LOCATION_ID	INT	NULL	FOREIGN KEY

	D_LICENSE_NUM...	RENTAL_ID	CLASS_RENT...	ODOMETER_B...	ODOMETER_AFT...	GAS_AFTER_RENT	RENTAL_...	RETURN_DATE	RENTAL_DUR...	PICKUP_LO...	DROPOFF...
1	C4006-011075-12	1	1	12300	14540	QUARTER FULL	2022-06-10	2022-06-18	8	1	3
2	C6018-311299-37	4	4	2500	4000	EMPTY	2022-06-12	2022-06-18	6	3	1
3	F4172-100995-06	3	2	8700	9300	THREE QUARTER F...	2022-06-05	2022-06-09	4	2	4
4	G3002-041189-11	2	3	16720	17580	HALF FULL	2022-06-01	2022-06-04	3	4	5

Table Name	Attrributes	Data Type	NULL	CONSTRAINTS
PROMOTION	CLASS_ID	INT	NOT NULL	PRIMARY/ FOREIGN KEY
	PROMOTION_ID	INT	NOT NULL	PRIMARY KEY
	DISCOUNT_RATE_PERCENT	INT	NULL	
	PROMOTION_START_DATE	DATE	NULL	
	PROMOTION_END_DATE	DATE	NULL	

	CLASS_ID	PROMOTION_ID	DISCOUNT_RATE_PERCENT	PROMOTION_START_DATE	PROMOTION_END_DATE
1	1	101	50	2022-06-10	2022-06-18
2	2	201	30	2022-06-03	2022-06-09
3	3	301	40	2022-05-25	2022-06-01
4	4	401	40	2022-05-17	2022-05-23

Table Name	Attrributes	Data Type	NULL	CONSTRAINTS
DROP_OFF_ CHARGE	D_LICENSE_NUMBER	VARCHAR(30)	NOT NULL	PRIMARY/ FOREIGN KEY/CHECK
	RENTAL_ID	INT	NOT NULL	PRIMARY/ FOREIGN KEY
	BILLING_ID	INT	NOT NULL	PRIMARY KEY
	CLASS_ID	INT	NOT NULL	FOREIGN KEY
	LICENSE_PLATE_NUM	VARCHAR(20)	NULL	
	PROMOTION_ID	INT	NULL	FOREIGN KEY
	AMOUNT_DUE	MONEY	NOT NULL	DEFAULT
	PAYMENT_DATE	DATE	NOT NULL	

	D_LICENSE_NUMBER	RENTAL_ID	BILLING_ID	CLASS_ID	LICENSE_PLATE_NUM	PROMOTION_ID	AMOUNT_DUE	PAYMENT_DATE
1	C4006-011075-12	1	1001	1	ABC-123	101	280.00	2022-06-18
2	C6018-311299-37	4	1004	4	FRS-209	NULL	780.00	2022-06-18
3	F4172-100995-06	3	1003	2	CDE-789	201	252.00	2022-06-18
4	G3002-041189-11	2	1002	3	XYZ-456	301	198.00	2022-06-18

CHALLENGES AND IMPROVEMENTS:

Challenges

- Stablished business rules and assumptions from project scenario is a first challenge.
- Design an accurate ERD and later converted to Relational Schema is also another challenge.
- We encountered difficulty of converting to two chain weak entities into a relationship schema.
- Dividing the work equally for DDL and DML gave us a little problem. Since everything should match from data type definition, any constraints addition or modification to size of a data.
- Time Constraint. We would like to add more functionality like membership discount, late return fee, renting accessories (ex. GPS, bike rack,...) etc. but due to lack of time we had to stick to what is required to be able to respect the submission deadlines.

Recommended Improvements

- Learning the common bad practices in designing the database would be helpful in avoiding those mistakes.

- More time doing the project could help us improve and add more functionality to the database system.

- We should have had divided the work for deliverable 2 in such a way that one will work on DDL and one will do DML afterwards instead of dividing the relations and doing the DDL and DML separately.

- Injecting some advance techniques and putting it to practice would help us to get familiar with it.

- More practice performing normalization.

CONCLUSION AND FUTURE WORK

This project really helped us practice what we have learned during the class. We were able to apply the concepts we learned, and also we were able to learn new things like surrogate keys and converting two connecting weak entities into a relationship schema. We would have probably improved and add more functionality to the system with more time. Effective teaching, plenty of related examples practice and good structure of project document also help us to better understand to finish our project. The project document is well structured and was easy to follow. Deadlines of the deliverables were given with ample time. We would also like to mention the dynamics of our team. Two of us had a chance to do all the work on our own and make a comparison after to finalize every deliverable. We were able to practice not just as a team but also individually. Moving forward, future work can still be done in improving and adding functionalities to this project. Testing it further and implementing advanced SQL techniques will be helpful in making the system more robust and effective.

Overall, this project was beneficial for us in putting all learnings into practice. We are pleased with the work that our team done.

REFERENCES

Class notes, assignments and lab documents.

Online lectures:

C. Coronel and S. A. Morris, Database Systems Design,
implementation, and management. Cengage, 2019.

"Relational data model in dbms: Concepts, constraints, example.":
https://www.guru99.com/relational-data-model-dbms.html

"A Quick-start tutorial on Relational Database Design.":
https://www3.ntu.edu.sg/home/ehchua/programming/sql/Relational_Database_Design.html

"Er model - basic concepts." :
https://www.tutorialspoint.com/dbms/er model basic concepts.htm