Data and Applications
Phase III
for
Amusement Park Management

Prepared by:
Kalyan Adithya
Jaiwanth Mandava
Vivek Pamnani

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1 The ER Model

1.1 The Diagram

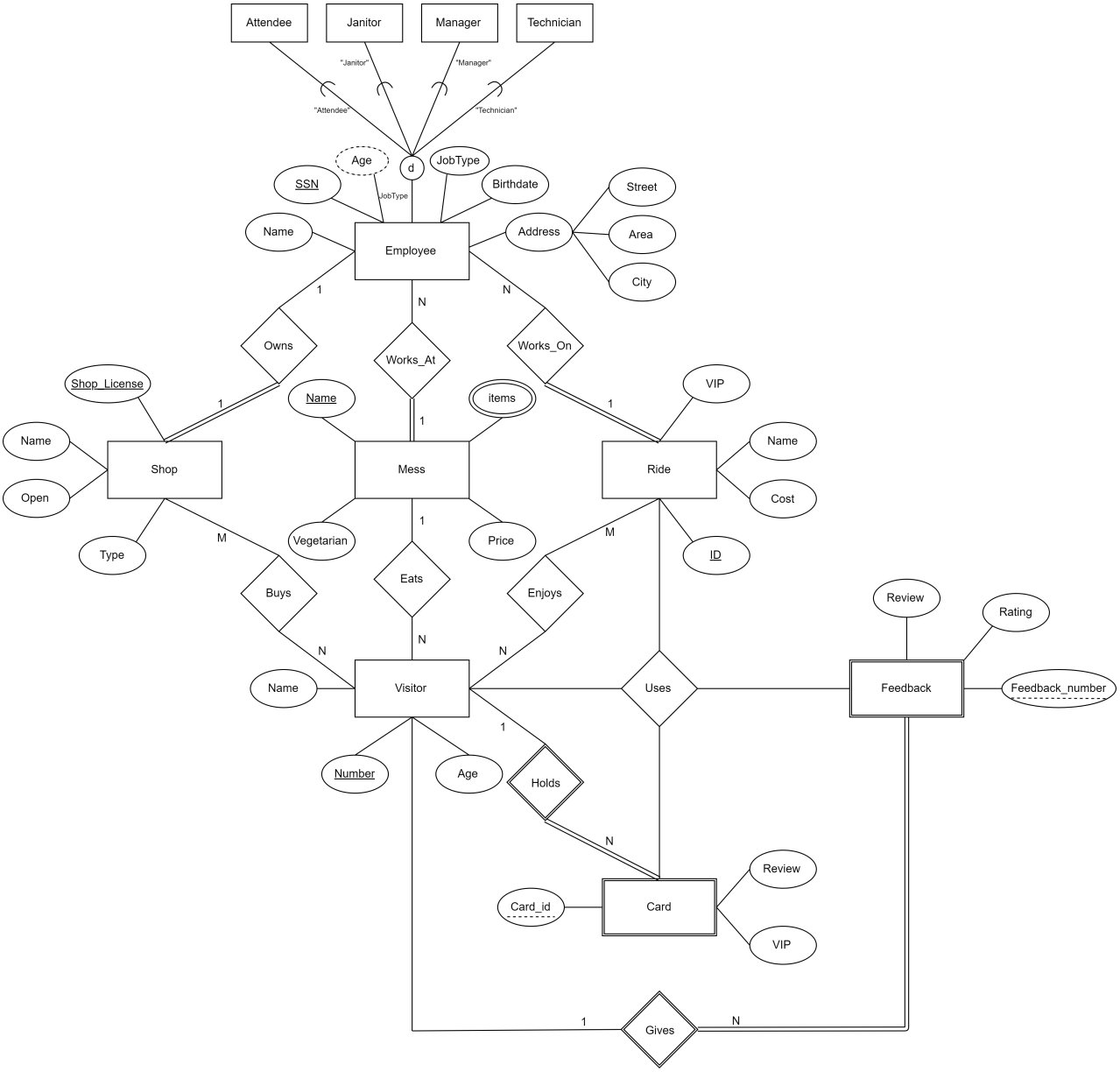

Figure 1: ER Model

Figure 1 describes the ER diagram for the mini-world Amusement Park.

1.2 Is it different from Phase II? Not really.

The ER Diagram is different from Phase II in the sense of positioning of elements. There have been no logical changes to the diagram, apart from:

- Added attribute 'JobType' to entity type 'Employee'.
  Reason: To have a attribute-defined specialization instead of a user-defined specialization under the entity type 'Employee'.

1.3 Assumptions

Before moving on to relational models, let us clarify some mini-world assumptions to avoid any ambiguity:

1. If a relationship V-Enjoys-R (V is member of 'Visitor'; R is member of 'Ride') exists, then V-Gives-F (F is member of 'Feedback') exists.
2. Attribute 'Feedback_number' of 'Feedback' is Visitor defined. Meaning, that a 'Feedback_number = n' signifies a Visitor's n^{th} feedback/review.
3. Attribute 'Card_id' of 'Card' is Visitor defined. Meaning, that a Card_id is not generalized/unique. 'Card_id = n' signifies a Visitor's n^{th} held card.
4. An 'Employee' E can either participate in:
   E-Owns-S (S is member of 'Shop')
   OR
   E-Works_On-R (R is member of 'Ride') and/or E-Works_At-M (M is member of 'Mess') relationship.

2 Stepwise ER Model → Relational Model

2.1 Mapping Regular Entity Types

2.1.1 Visitor

Number	Name	Age

2.1.2 Employee

SSN	Name	Birthdate	Age	Street	Area	City	JobType

2.1.3 Shop

Shop_license	Name	Open	Type

2.1.4 Mess

Name	Price	Vegetarian

Note: Multivalued attribute 'Items' is incorporated in a new relation 'Mess_food' (2.7.1 on page 5).

2.1.5 Ride

ID	Name	VIP	Cost

2.2 Mapping of Weak Entity Types

2.2.1 Card

Visitor_number	Card_id	Balance	VIP

2.2.2 Feedback

Visitor_number	Feedback_number	Rating	Review

2.3 Mapping of 1:1 Relationship Types

2.3.1 Owns

No new relation defined. Entity type 'Shop' has total participation. Thus, foreign key of 'Employee' SSN will be incorporated in relation 'Shop' as 'Owner_SSN'.

2.4 Mapping of 1:N Relationship Types

2.4.1 Works_At

No new relation defined. Entity type 'Employee' will incorporate foreign key of 'Mess' Name as 'Assigned_mess'.

2.4.2 Works_On

No new relation defined. Entity type 'Employee' will incorporate foreign key of 'Ride' ID as 'Assigned_ride_id'.

2.4.3 Eats

No new relation defined. Entity type 'Visitor' will incorporate foreign key of 'Mess' Name as 'Eats_at'.

2.5 Resulting Changes to Existing Relations

2.5.1 Visitor (from 2.1.1)

Number	Name	Age	Eats_at

2.5.2 Employee (from 2.1.2)

SSN	Name	Birthdate	Age	Street	Area	City	JobType	Assigned_mess	Assigned_ride_id

2.5.3 Shop (from 2.1.3)

Shop_license	Name	Open	Type	Owner_SSN

2.6 Mapping of M:N Relationship Types

2.6.1 Buys

New relation defined 'Buys' with primary key {Vistor_number, Shop_license}. No additional attributes are specified.

Visitor_number	Shop_license

2.6.2 Enjoys

New relation defined 'Enjoys' with primary key {Vistor_number, Ride_id}. No additional attributes are specified.

Visitor_number	Ride_id

2.7 Mapping of Multivalued Attributes

2.7.1 Mess_Food

New relation defined with primary key {Name, Item}.

Name	Item

2.8 Mapping of n-ary Relationship Types

2.8.1 USES

New relation defined with primary key {Visitor_number, Card_id, Feedback_number, Ride_id}. No additional attributes are specified.

Visitor_number	Card_id	Feedback_number	Ride_id

2.9 Mapping of Specialization Hierarchies

2.9.1 Employee

We define a single relation (here, 'Employee') with one type attribute because:

- No specialized attributes were defined for a subclass.
- Subclasses participate in relationships as a generalization 'Employee'.

3 Relational Model from the ER Model

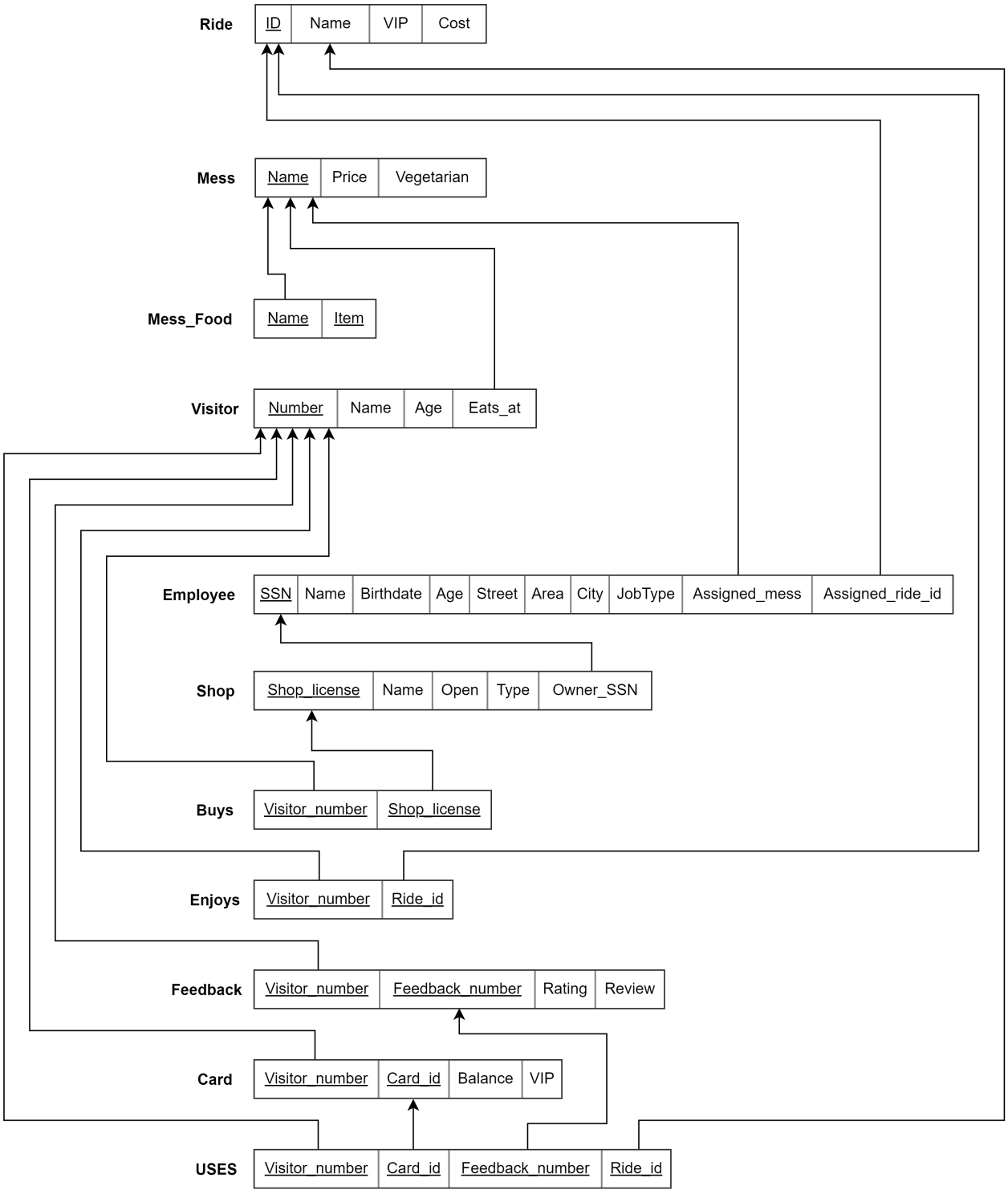

Figure 2: Relational Model

4 Conversion of Relational Model to 1NF Relational Model

The model shown in figure 2 (page 6) satisfies the conditions for 1NF (first normal form).

Reasoning:

1. No relation constitutes of a composite attribute.
2. No relation constitutes of a multivalued attribute.
   Note: 2.7.1 has attribute 'Item' which decomposes the multivalued attribute 'Items' (from relation 'Mess'), resulting in redundancy in relation 'Mess_food' (2.7.1).
3. No nested relations.

5 Conversion of 1NF Relational Model to 2NF Relational Model

The model shown in figure 2 (page 6) satisfies the conditions for 2NF (second normal form).
Consider the FDs (functional dependencies):

1. {Visitor_number, Feedback_number} → Rating
2. {Visitor_number, Feedback_number} → Review
3. {Visitor_number, Card_id} → Balance
4. {Visitor_number, Card_id} → VIP

Here, 'Rating', 'Review', 'Balance', 'VIP' are non-prime attributes.
Reasoning:

1–2. A Visitor may submit many Feedbacks. Visitor_number is not sufficient to distinguish between two given Ratings/Reviews.
   Similarly, many Visitors may have an n^{th} Feedback_number. Since Feedback_number is defined Visitor specific (from weak entity 'Feedback', see 2.2.2), it is not sufficient to distinguish between two given Ratings/Reviews.

3–4. A Visitor may hold many Cards. Visitor_number is not sufficient to distinguish between two given Cards holding different balances and/or VIP status.
   Similarly, many Visitors may have an n^{th} Card_id. Since Card_id is defined Visitor specific (from weak entity 'Card', see 2.2.1), it is not sufficient to distinguish between two given Cards holding different balances and/or VIP status.

Thus, we can conclude that all functional dependencies are Full FDs.

6 Conversion of 2NF Relational Model to 3NF Relational Model

The conditions of a relational model being in 3NF (third normal form) are:

1. The relation schema is in 2NF.
2. No non-prime attribute in the relation schema is transitively dependent on the primary key.

Condition 1 is satisfied.
Condition 2 is not satisfied.

We can observe that the problem arises at the derived attribute 'Age' under the relation 'Employee'. Consider a member E of 'Employee' with SSN 'S', Birthdate'B' and Age 'A'. Then we can enlist two functional dependencies:
SSN $\rightarrow$ Birthdate, AND Birthdate $\rightarrow$ Age.
Implying, SSN $\rightarrow$ Age.

Here we observe that non-prime attribute 'Age' is transitively dependent on the primary key 'SSN' which shows that condition 2 is not satisfied. To rectify this, we decompose the relation 'Employee' into two relations 'Employee' and 'Emp_Age'.
Like,

Where, Employee.Birthdate is a foreign key referencing Emp_age.Birthdate.

7 The Final 3NF Relational Model

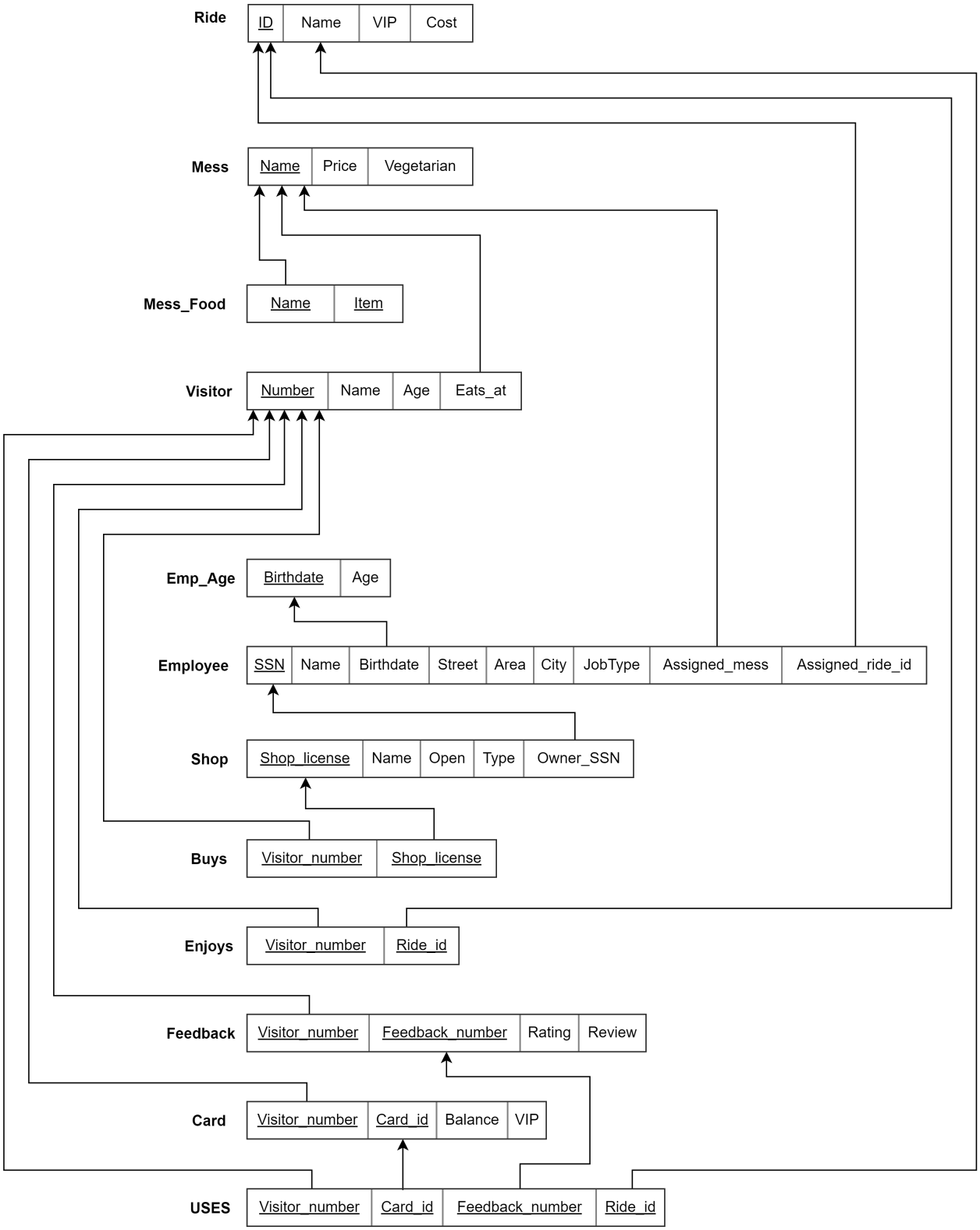

Figure 3: 3NF Relational Model

8 Example States

8.1 Examples

8.1.1 Employee

SSN	Name	Birthdate	Street	Area	City	Job_type	Assigned_mess	Assigned_ride_id
3921832	Ravi Shastri	31-01-1955	Prof. CR Rao	Gachibowli	Hyderabad	Manager	NULL	NULL
3213233	Ganguly	23-03-1965	Nizampet	Kukatpally	Hyderabad	Technician	Bawarchi	1
3214321	Anil Kumble	01-01-1977	Yousufguda	Ameerpet	Hyderabad	Manager	NULL	NULL
3124321	Bajji	08-08-1974	Krishna Nagar	S.R.Nagar	Hyderabad	Manager	NULL	NULL
3123444	Shane Warner	19-02-1978	Street-1	Jubliee Hills	Hyderabad	Janitor	Paradise	2
3354213	Anushka Sharma	29-02-1980	Street-1	Banjara Hills	Hyderabad	Manager	NULL	NULL
3356666	Deepthi Sunaina	29-02-1980	Street-1	Banjara Hills	Hyderabad	Manager	NULL	NULL
3902394	Mahesh	21-04-1988	LB Nagar	Coca Cola Industry	Secundrabad	Attendee	Dominos	4
3783938	Padma	30-06-00	CB street	Big Time	Secundrabad	Manager	Paradise	3
3783939	Warner	30-06-00	CB street	Big Time	Secundrabad	Janitor	Paradise	5
3783940	steve	20-05-99	Street-18	kool_cart	Hyderabad	Manager	Chutneys	1
3783941	Maxwell	20-05-99	Street-19	kool_cart	Hyderabad	Attendee	Bawarchi	2
3783942	Bisky	29-02-1980	Yousufguda	Banjara Hills	Hyderabad	Technician	Bawarchi	6

8.1.2 Emp_age

Birthdate	Age
31-01-1955	64
23-03-1965	54
01-01-1977	42
08-08-1974	45
19-02-1978	41
29-02-1980	39
29-02-1980	39
21-04-1988	31
30-06-2000	19
30-06-2000	19
20-05-1999	20
20-05-1999	20
19-02-1978	41

8.1.3 Visitor

Number	Name	Age	Eats_at
2018000	Sachin	43	Paradise
2018001	Sehwag	41	Chutneys
2018002	Dhoni	37	Bawarchi
2018003	Kohli	30	Dominos
2018004	Bumrah	25	Chutneys
2018005	Umesh	27	Bawarchi
2018006	Ishant	29	Chutneys

8.1.4 Mess

Name	Price	Vegetarian
Chutneys	$10	Yes
Paradise	$10	No
Bawarchi	$8	No
Dominos	$12	No

8.1.5 Mess_food

Name	Items
Chutneys	Veg Thali
Chutneys	Panner Butter Masala
Chutneys	Rotis
Paradise	Chicken Biryani
Paradise	Mutton Biryani
Paradise	Rotis
Paradise	Chill Chicken Curry
Paradise	Coca-Cola
Bawarchi	Chicken Biryani
Bawarchi	Mutton Biryani
Bawarchi	Rotis
Bawarchi	Chill Chicken Curry
Bawarchi	Coca-Cola
Dominos	Veg Pizza Mania
Dominos	Non-Veg Pizza Mania
Dominos	Garlic Breads
Dominos	Pepsi

8.1.6 Shop

Shop_license	Name	Open	Type	Owner_SSN
SH101	Sachin Gift Shop	Yes	Gifts,Novelties	3356666
SH102	Virat chappals	Yes	Footwear	3354213
SH103	Kumble Klothing	Yes	Clothing	3214321
SH104	Bajji Sweets	No	Sweet Shop	3124321
SH105	Ravi Wines	Yes	Exclusive imported wine	3921832

8.1.7 Ride

ID	Name	VIP	Cost
1	Roller Coaster	Yes	$10
2	Water Ride 1	No	$2
3	Water Ride 2	No	$2
4	Water Ride 3	Yes	$5
5	Hurricane	Yes	$10
6	Insanity	No	$3

8.1.8 Buys

Visitor_number	Shop_license
2018003	SH105
2018004	SH102
2018005	SH102
2018005	SH103

8.1.9 Enjoys

Visitor_number	Ride_id
2018001	1
2018001	2
2018002	6
2018005	2
2018006	3

8.1.10 Feedback

Visitor_number	Feedback_number	Rating	Review
2018001	F001	2	Had to wait 30 mins to get into the ride.
2018001	F002	5	Awesome experience!
2018002	F001	3	Decent.
2018005	F001	4	Great Ride
2018006	F001	4	Cheap and fun.

8.1.11 Card

Visitor_number	Card_id	Balance	VIP
2018001	C001	$20	Yes
2018001	C002	$10	No
2018002	C001	$15	No
2018003	C001	$12	No
2018005	C001	$18	Yes
2018006	C001	$20	No

8.1.12 USES

Visitor_number	Card_id	Feedback_number	Ride_id
2018001	C001	F001	1
2018001	C002	F002	2
2018002	C001	F001	6
2018005	C001	F001	2
2018006	C001	F001	4

8.2 Justification

Key Constraint:
All primary keys are underlined and no two tuples from a table share the same primary key.
Therefore, Key Constraint is satisfied.

Entity Integrity Constraint:
All primary keys have non-NULL values.
Therefore, Entity Integrity Constraint is satisfied.

Referential Integrity Constraint
All foreign keys either have valid OR NULL values. There exist no invalid foreign keys.
Therefore, Referential Integrity Constraint is satisfied.