DSE 310 : Assignment 1

Rita Abani 19244

We have a relational database schema titled 'Aircraft Information' that consists of three relational schemas Engine, Manufacturer and Airliner which are listed below with their schema and respective SQL data types.

- **Engine(Integer : S.NO, Varchar: Engine_name, Varchar: Engine_ID)**

This schema stores information on the type of jet engine used in the aircraft.

- **Manufacturer (Varchar: Engine_ID, Varchar: Manufacturer_name, Varchar: Manufacturer_ID, Varchar: Headquarter)**

This schema contains information of the companies that manufacture the jet engines for the aircrafts.

- **Airliner (Varchar: Airline_Brand, Varchar: Air_ID, Varchar: Engine_ID , Float: Top_Speed)**

This schema contains the information on the Airliners, their associated engines used and the maximum speed that they can fly in.
Engine

I have designed the relational schemas below with some research done on the sample types.

Engine

S.NO	Engine_name	Engine_ID
1	Turbojet	11j
2	Turboprop	12p
3	Turbofan	13f

Manufacturer

Engine_ID	Manufacturer_name	Manufacturer_ID	Headquarter
11j	Rolls Royce	RR1	London
11j	Pratt & Whitney	PW2	Connecticut
11j	Williams International	WI3	Michigan

12p	Rolls Royce	RR1	London
12p	GE Aviation	GA4	Ohio
12p	Honeywell Aerospace	HA5	Arizona
13f	Rolls Royce	RR1	London
13f	Klimov	KK6	St. Petersburg
13f	EuroJet	EJ7	Berlin

Airliner

Airline_Brand	Air_ID	Engine_ID	Top_Speed (in km/h)
Etihad	E1	13f	1020.32
Lufthansa	L1	12p	840
Concorde	C1	11j	2179
Indigo	I1	13f	154
Cathay Pacific	PC1	12p	1931.213

The following questions have been framed involving the above three tables.
σ refers to the select operator that selects rows with conditions
π is the projection operator
⋈ is the natural join operator
U and - are set operators denoting union and subtraction respectively
Other predicate calculus related terminologies

1) **FInd all the airliner's details whose top_speed is greater than 2000km/h**

The Relational Algebra expression for this problem is :

$\sigma_{Top\_Speed > 2000}$**(Airliner)**

The Tuple Relational Calculus expression for the problem can be written as:

{ t | t ∈ Airliner Λ t[Top_speed] >2000}

Where t is the resulting tuple and the rest is the predicate wherein t[Top_speed] is the tuple variable on which we are placing conditions

The Domain Relational Calculus expression for this problem is :

{ <a,i,e,t> | <a,i,e,t> ∈ Airliner Λ (t >2000) }

Where a, i , e and t are domain variables corresponding to all the columns of the Airliner table in sequence

The following are some extra questions solved using Relational Algebra

2) **Obtain the location of headquarters for the Turbofan engine manufactured by Klimov**

In this question, we need to first obtain the Engine ID for Turbofan from the Engine table and then join the Manufacturer table with the Engine Table using the common attribute 'Engine_ID'. Then the record from the Manufacturer table where Klimov is the company is outsourced. Then we project the resultant Headquarter from the obtained output.

$$\pi_{Headquarter}(\sigma_{Engine\_name = \text{“Turbofan”}}(Engine) \bowtie \sigma_{Manufacturer\_name=\text{”Klimov”}}(Manufacturer))$$

3) **FInd the engine manufacturer and Engine type of the airline whose top_speed is greater than 2000km/h**

This question involved the use of select operator on three tables to be joined through the common attribute 'Engine_ID'. The record from the joint operation where Top_speed >2000 is obtained. A projection operator is then used to retrieve the Manufacturer_name and the Engine_name from the resultant output.

$$\pi_{Manufacturer\_name,\ Engine\_name}(\sigma_{Top\_speed > 2000}(Engine \bowtie Manufacturer \bowtie Airliner))$$

4) **Give all the manufacturer details of the Engines manufactured by EuroJet or Pratt & Whitney**

We use a union operation here to combine the individual results of the select operator applied onto the Manufacturer table for the two companies.

$$(\sigma_{Manufacturer\_name=\text{”EuroJet”}}(Manufacturer)) \cup (\sigma_{Manufacturer\_name=\text{”Pratt \& Whitney”}}(Manufacturer))$$

5) **List all the places or headquarters which do not have an airliner with the Air_ID of C1**

The projection of Engine ID from the Airliner table for the record of Air_ID = C1 is subtracted from the Engine ID projected from the Manufacturer table. The output is joined with the Manufacturer table using the common key of Engine ID to project the Headquarter location.

$$\pi_{Headquarter}(Manufacturer \bowtie (\pi_{Engine\_ID}(Manufacturer) - \pi_{Engine\_ID}(\sigma_{Air\_ID = \text{“C1”}}(Airliner))$$

6) **State the manufacturer names of all those airliners whose maximum speed of cruising lies between 1000 and 2000 km/h (excluding 1000 and 2000).**

We find the projection of the company name from the result obtained by applying the select operation condition on the join of Manufacturer and Airliner schemas

$$\pi_{Manufacturer\_name}(\sigma_{Top\_speed>1000 \wedge Top\_speed<2000}(Manufacturer \bowtie Airliner))$$

Now we explore the use of Relational Calculus which encompasses both Tuple Relational Calculus as well as Domain Relational Calculus.

Tuple Relational Calculus :

7) **Name the airliner(s) that run by exhausting the Turbojet Engine.**

The Tuple Relational Calculus expression for the problem can be written as:

$$\{ t \mid \exists s \in Airliner (t[Airline\_brand] = s[Airline\_brand] \wedge \exists u \in Engine(u[Engine\_name] = \text{“Turbojet”} \wedge u[Engine\_ID] = s[Engine\_ID])) \}$$

Domain Relational Calculus

8) **Find the company name, manufacturing ID and the location of its headquarters for which Manufacturer ID is HA5.**

The Domain Relational Calculus expression for the problem can be written as:

$$\{ < m, i, h > \mid <m, i, h> \in Manufacturer \wedge (i = \text{“HA5”}) \}$$

Where m, i and h represent the resulting domain variables corresponding to Manufacturer_name, Manufacturer_ID and Headquarter respectively.

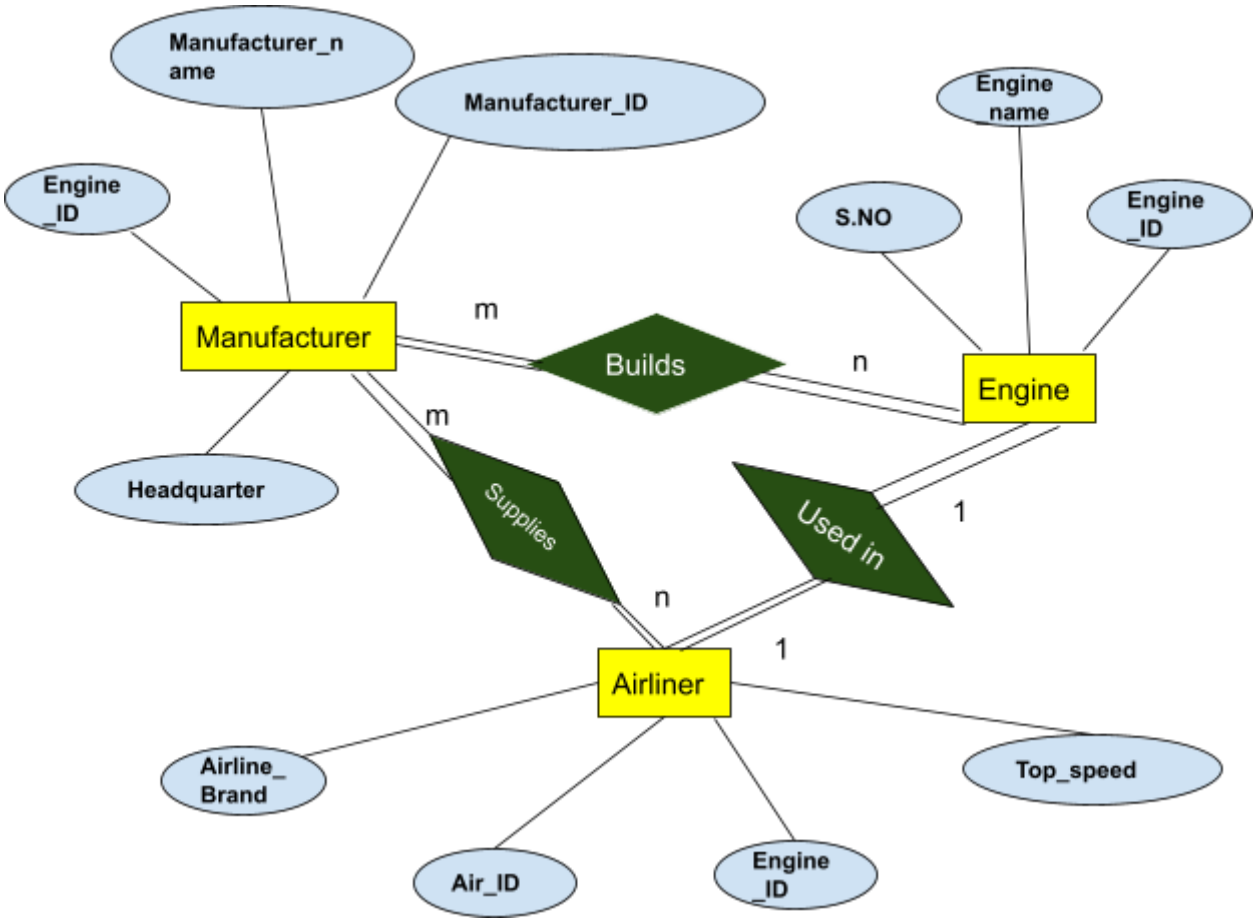
9) **What are the names if the Airliner and its maximum speed corresponding to the Air_ID of 'I1'**

The Domain Relational Calculus expression for the problem can be written as:

{ < a , t > | < a , d , t > ∈ Airliner Λ d = "I1" }

Where a, d and t represent the domain variables corresponding to Airline_Brand, Air_ID and top_speed respectively.

The following is the Entity Relationship Diagram for our Entity Relationship model 'Aircraft Information'



The double lines represent total participation

Practical applications of Relational Algebra and Relational Calculus applied to the above scenario :

This has many practical applications: For example in determining the areas over which permit of flight is required. Places like Dubai have a top speed limit < 1000 km/h owing to tall building structures, hence aircrafts like Concorde cannot operate on such terrains in the same high speed, they can only operate at a lower speed.

Another application could be for quickly finding the headquarter and subsequently office location, mail and other details from one value like Manufacturer_ID or an aircraft detail making contacting easier.

I have tried to highlight these practical applications through the questions designed above.