

The Mini-World

The mini-world we have considered consists of the **Airports in India**.

The database is a **CENTRAL AIRPORTS MANAGEMENT DATABASE** and its users are the **personnel at the airport, the air travellers and their relatives**. This database is well-connected to the rest of the airport modules: airline databases, revenue management, and air traffic management.

This database has a lot of functionality like:

- Keeping track of flight status and schedules for the travellers to know about flight cancellation, flight delays
- Supervision of aircraft landing and take off, airport traffic management, runway status management
- Retrieval of information regarding airport finances: staff payrolls, etc
- Baggage tagging from the time the baggage is loaded and its tracking until the destination is reached and the bag is returned to the owners.
- Keeping a record of a passenger’s journey from passenger processing (check-in, boarding) and baggage handling (dropping and handling) to the moment he boards the aircraft
- Retrieving information for different segments of users: passengers, airport staff, crew, or members of specific departments, authorities, business partners, or police.

DATABASE REQUIREMENTS

STRONG ENTITY TYPES

- **Passenger**

The PASSENGER entity stores data about the passenger which primarily includes their personal information.

Attribute Name	Domain Constraints	Attribute Type	Description
Name	Maximum 50 characters	Composite single valued	Name can contain: First, middle and last name
SSN number	12 digit number	Key Attribute	Eg. 1900-1800-3400

Gender	Male/Female/Others	Single	
DOB	{DD-MM-YYYY}	Single	
Age	Number	Derived	Derived from DOB
Senior Citizen	{Yes,No}	Single	attained the age of '60 years and above'
Nationality	Valid country name	Single	Eg. Indian
EMAIL-ID	Valid email-id	Single	
Current Address	String	Composite	
Zone of current address (COVID-Related Info)	{Red,Orange,Green}	Single	<ul style="list-style-type: none"> ● Red Zone: Areas or the hotspots classified as those with the highest caseload. ● Orange Zone: Areas which have reported a limited number of cases in the past and no surge in positive cases recently. ● Green Zone: Areas with zero confirmed cases till date or no confirmed case in the last 21 days.

● Aircraft

Attribute Name	Domain Constraints	Attribute Type	Description
<u>Registration Number</u>	Number	Key Attribute	An aircraft registration is a code unique to a single aircraft, required by international convention to be marked on the exterior of every civil aircraft.
OWNER Airline	String max 50 characters	Multivalued	Eg. IndiGo, Spicejet
Capacity	Number	Single	Number of People that can board the aircraft including flight crew
Manufacturer	String	Single	Eg: Airbus, Boeing
Plane model	Alphanumeric	Single	Eg: 737,747, A380
Distance travelled	In Kms	Single	
Last maintenance check date	{DD-MM-YYYY}	Single	Eg. 23-5-2020
Flight ID	String	Single	The alphabetical part is the IATA code of the airline followed by a number Eg: 6E-123,SG-909

● Airline

Attribute Name	Domain Constraints	Attribute Type	Description
<u>IATA airline designators</u>	2-LETTER CODE	Key Attribute	Eg: 6E for IndiGo
Company name	String max 50 characters	Single	Eg. IndiGo
Number of aircrafts owned	Number	Single	
Active	{Y/N}	Single	"Y" if the airline is or has until recently been operational, "N" if it is defunct.
Country Of Ownership	String	Single	Eg. For Air Asia it would be Malaysia.

● Airport

Name	Domain Constraints	Attribute Type	Description
<u>IATA airport codes</u>	String (3 chars, A - Z)	Key Attribute	The three-letter IATA code for the airport .Eg.HYD, DEL
Airport Name	String	Single	The official airport name, including "Airport", "Airstrip", etc.(London Heathrow Airport)
City	String	Single	Eg. New Delhi
Country		Single	
Coordinates	Pair of simple attributes(Latitude and Longitude)	Composite Key Attribute	
Latitude	Floating Point[-90,90]	Simple Child Attribute	The airport latitude in decimal degrees (positive for north).
Longitude	Floating Point[-180,180]	Simple Child Attribute	The airport longitude in decimal degrees (positive for east).
Altitude	Integer	Single	Altitude in meters from mean sea level

Time Zone	Fractional in GMT	Single	Eg. IST is +5:30 GMT. Fractional hours are expressed as decimals, eg. India is 5.5.
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● Luggage

Name	Domain Constraints	Attribute Type	Description
BAGGAGE ID	10 digit number	Key Attribute	"7" is the "leading digit" + "512" is the 3-digit airline code + "123456" is the 6-digit bag number.
Name	String		Name of Passenger Identified with the Baggage (Last Name, First Name)
IATA airport code of Destination Airport	String (3 chars, A - Z)	Single	The three-letter IATA code for the airport .Eg. HYD, DEL
Flight ID	String	Single	The alphabetical part is the IATA code of the airline followed by a number Eg: 6E-123, SG-909
PNR number	NUMERIC	Single	airline's internal identifier for flight booking within their computer system

● BOARDING PASS

Name	Domain Constraints	Attribute Type	Description
BARCODE NUMBER	Number	Key Attribute	
Name	String	Single	Name of Passenger Identified with the Baggage (Last Name, First Name)
IATA airport code of Source Airport	String (3 chars, A - Z)	Single	The three-letter IATA code for the airport .Eg. HYD, DEL
IATA airport code Destination of Airport	String (3 chars, A - Z)	Single	The three-letter IATA code for the airport .Eg. HYD, DEL

Flight ID	String	Single	The alphabetical part is the IATA code of the airline followed by a number Eg: 6E-123,SG-909
PNR number	NUMERIC	Single	Airline's internal identifier for your flight booking within their computer system
Class of travel	{Economy or Business}	Single	
Flight date of departure	DD-MM-YYYY	Single	In local date of source AIRPORT
Scheduled Departure time	HH:MM format	Single	In local time of source AIRPORT
Scheduled Boarding Time	HH:MM format	Single	In local time of source AIRPORT
Terminal number	Alphanumeric	Single	Eg. T1, T3
Seats	Alphanumeric: number followed by letter	Single	Eg. D4, A3
Special services	Wheelchair, Disability Assistance, XL seats, Priority Boarding	Multi-valued	

● AIRLINE EMPLOYEES

The AIRLINE EMPLOYEES entity type comprises all employees employed by the AIRLINE.

Name	Domain Constraints	Attribute Type	Description
Name	Maximum 50 character	Composite single valued	Name can contain: First, middle and last name
Aadhar card number	12 digit number	Key Attribute	Eg. 1900-1800-3400
Gender	Male/Female/Others	Single	
Nationality	Valid country name	Single	Eg. Indian
DOB	{DD-MM-YYYY}	Single	
Experience	Number	Single	Years of experience in the air-travel field
Salary	Number	Single	

Languages spoken		Multivalued	Eg: {French, English, Hindi}
IATA airline designator of EMPLOYER AIRLINE	2-LETTER CODE	Single	Eg: 6E for IndiGo

The staff can be of two main subclasses:

A) FLIGHT CREW:

This has the following subclasses and their respective extra attributes:

I) PILOT

Attribute Name	Domain Constraints	Attribute Type	Description
PILOT License number	2-LETTER CODE	Key Attribute	Eg: 6E for IndiGo
Number of flying hours achieved	HHHHH:MM format	Single	Where HHHHH is a 5 digit number and MM is a 2-digit number less than 60

II) Flight attendants

Attribute Name	Domain Constraints	Attribute Type	Description
Training/Education	String	Multivalued	Eg: Bachelor's Degree in Hospitality Management
Past experiences	String	Multivalued	

III) Flight engineers

A flight engineer is the member of an aircraft's flight crew who monitors and operates its complex aircraft systems.

Attribute Name	Domain Constraints	Attribute Type	Description
Education	String	Multivalued	Eg: Bachelor's Degree in Engineering

Aircrafts Specialized in	Manufacturer+plane id	Multivalued, Composite	Airbus 380, Boeing 747
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B) ON-GROUND EMPLOYEES

This subclass has only one additional attribute : JOB TITLE

Some possible values of this are :

- **Ground / Airport Station Attendant**

The main responsibility is to assist passengers in the terminal with general questions regarding directions, terminal services, or arranging wheelchair access.

- **Aviation Meteorologist**

They determine current and forecasted weather conditions for all altitudes, including the direction and speed of wind, cloud cover, and precipitation.

- **Passenger Service Agent**

Their duties include issuing refunds to passengers, computing fares, preparing and selling tickets, collecting charges for excess baggage, checking baggage, and providing travel information.

- **Ramp Planner**

They coordinate a variety of departments or contracted companies that must perform various tasks on the aircraft before it can depart for the next flight.

- **AIRPORT-EMPLOYEES**

The AIRPORT EMPLOYEES entity type comprises all employees working for the airport

Name	Domain Constraints	Attribute Type	Description
Name	Maximum 50 character	Composite single valued	Name can contain: First, middle and last name
Aadhar card number	12 digit number	Key Attribute	Eg. 1900-1800-3400
<u>IATA airport codes</u> of employing	String (3 chars, A - Z)	Single	The three-letter IATA code for the airport Eg.HYD, DEL

airport			
Gender	Male/Female/Others	Single	
Nationality	Valid country name	Single	Eg. Indian
DOB	{DD-MM-YYYY}	Single	
Experience	Number	Single	Years of experience in the air-travel field
Salary	Number	Single	

The staff can be of three main subclasses:

I) AIR TRAFFIC CONTROLLER:

Air traffic control specialists, abbreviated ATCS, are personnel responsible for the safe, orderly, and expeditious flow of air traffic in the global air traffic control system.

Attribute Name	Domain Constraints	Attribute Type	Description
Training/Education	String	Multivalued	Eg: Bachelor's Degree in Hospitality Management
Current communication Frequency	Floating point in MHz	Single	Current Radio voice frequency in megahertz

II) SECURITY

They are involved in screening passengers, baggage or cargo to ensure compliance with security regulations as well as deal with other security-threatening incidents.

Attribute Name	Domain Constraints	Attribute Type	Description
Designation	String	Single	Eg: Airport Security Director Security Manager Experienced Security Screener Entry-Level Security Screener
Security id number	Numeric 6 digit	Single	

III) MANAGEMENT AND OPERATIONS EXECUTIVES

This subclass has only one additional attribute : JOB TITLE

Some possible values of this are :

- **Airline Station Agent**

Responsible for coordination of flight crew, cargo crew, baggage crew, ground crew, and the information that must be communicated among all these teams.

- **Operations Agent**

Receiving and transmitting information from and to pilots, ground crew, and other personnel.

- **Airport Managers**

Responsible for overseeing the behind-the-scenes work of an airport, including maintenance and safety of the airfield, airport and airspace capacity management and airline scheduling.

WEAK ENTITY TYPES

- **ROUTE**

Name	Domain Constraints	Attribute Type	Description
Date	DD/MM/YYYY	Single	
Time duration	Time (24 hour style)	Single	Number of hours taken
Source airport	String (3 chars, A - Z) <u>IATA airport codes</u>	Single	The three-letter IATA code for the airport .Eg.HYD, DEL
Destination Airport	String (3 chars, A - Z)	Single	The three-letter IATA code for the airport .Eg.HYD, DEL
Direct / Stop-over	Bool	Derived	Direct (0), Stop-over(1) -> Derived from cardinality of stopover airports
<u>IATA airport codes</u> for Stopover airports	String (3 chars, A - Z) IATA airport codes	Multivalued	The three-letter IATA code for the airport .Eg.HYD, DEL
Status	{boarding, delayed,cancelled, final call, security, scheduled,DEPARTED}	Single	Status of flight
Taking off	Integer	Single	

runway ID			
Landing runway ID	Integer	Single	
Pilot's License numbers	Alphanumeric	Multivalued	
Distance involved	Number	Single	In Kms
Scheduled Departure	Time in HH:MM format	Single	
Scheduled Arrival	Time in HH:MM format	Single	

● TERMINAL

Name	Domain Constraints	Attribute Type	Description
Airplane Handling Capacity	Number	Single	Number of aircrafts which can be handled simultaneously
Floor Area	Number	Single	Area in metre sq.
ID	Alphanumeric	Partial key	Eg. T1,T3

● RUNAWAY

Name	Domain Constraints	Attribute Type	Description
ID	Number	Partial key	Runways are named by a number between 01 and 36, which is generally the magnetic azimuth of the runway's heading in decadegrees.
length_ft	Number	Single	Length of the full runway surface (including displaced thresholds, overrun areas, etc) in feet.
width_ft	Number	Single	Width of the runway surface in feet
Status	{Occupied, Vacant, Non-operational}	Single	

● EMERGENCY CONTACTS

Name	Domain Constraints	Attribute Type	Description
Name	String	Partial key	Name of the person to be contacted in case of emergency
Phone No.	10 digit number	Single	Phone Number of person to be contacted in case of emergency

RELATIONSHIP TYPES

➤ PASSENGER uses BOARDING PASS

One to many relationship (1:N) where PASSENGER could have used multiple boarding passes over a time-span to travel and Boarding Pass can be linked to exactly one passenger. (Total participation from Boarding pass)

➤ BOARDING PASS is used to travel on the ROUTE

Many to one relationship (N:1) where possession of a boarding pass by a passenger allows him to board the flight of that particular route. (Total Participation from Boarding pass side and partial participation from ROUTE side as some route may not have had any bookings yet)

➤ BAGGAGE is linked to BOARDING PASS

Many to one relationships (N:1) as several baggages can be linked to the same boarding pass. (Total Participation from Baggage side and partial participation from Boarding pass)

➤ AIRPORT is SOURCE airport for ROUTE

One to many relationships (1:N) as one airport can serve many routes but one route can have only one source airport. (Partial Participation from airport side as the airport may be one in construction and may not have an associated route yet; total participation from Route)

➤ **AIRPORT is DESTINATION for ROUTE**

One to many relationships (1:N) : One airport can act as a destination for many routes but one route can have only one destination airport. (Partial Participation from airport side as the airport may be one in construction and may not have an associated route yet; total participation from Route)

➤ **AIRCRAFT is used for the ROUTE**

One to many relationships (1:N) : A single aircraft can be used for many routes but each route will have only one flight. (Partial Participation from aircraft side and Total participation from Route)

➤ **FLIGHT CREW serves on the ROUTE**

This is a **many-to-many relationship(N:M)** as each route has several members of the cabin crew and each person can serve as a cabin crew member on several routes.

Min Constraint: As per International Guidelines, each flight must involve 5 members of the cabin crew (at least 2 pilots and 3 flight attendants). (Total Participation from Flight Crew and Total participation from Route)

➤ **AIRPORTS contains RUNWAYS**

One to many relationship(1:N): An airport has several runways which can be assigned to FLIGHTS by the AIR TRAFFIC CONTROLLER for both landing and taking off. (Total Participation from Airport and total participation from Runways)

➤ **AIRPORT contains TERMINALS**

One to many relationship(1:N) : An airport has several terminals but a terminal can belong to only one airport. (Total Participation from Airport side and total participation from Terminal)

➤ **AIRLINE owns the AIRCRAFT**

One to many relationship(1:N): Many aircrafts can be owned by an airline. (Total Participation from Airline side and total participation from Aircraft)

➤ **AIRLINE CREW works for the AIRLINE**

Many to one relationship(N:1): Each active airline has at least one operational flight route and hence must include 5 employees. (Total Participation from crew side and total participation from airline side)

➤ **AIRPORT CREW works in the AIRPORT**

Many to one relationship(N:1): Multiple crew members work at a single airport. (Total Participation from crew side and total participation from Airport)

➤ **PASSENGER has EMERGENCY CONTACTS**

One to many relationship(1:N)

Max constraint : A passenger is asked to assign a maximum of 3 emergency contacts during booking time. (Partial Participation from Passenger side and Total participation from Emergency Contact)

➤ **AIRPORT CREW (Manager) Supervises AIRPORT CREW(Subordinate)**

This is a recursive relationship where an airport employee lower in the hierarchy reports to the airport employee immediately above in the hierarchy.

➤ **PILOT(First-officer), FLIGHT ENGINEER, FLIGHT ATTENDANT have worked together under the command of the PILOT(Captain)(N-ary)**

This relationship may be used to judge the competence of the crew as a group.

This relation may come to analyze **frequent flight delay patterns ,air crash investigations etc.** For instance, in case of a mishap/accident, the investigators like to look at past reports to spot patterns of incompetent performance of the crew in previous flights they have been involved in together like flight delays, bad flight experiences, bad landings etc.

Normally, most airlines prefer to keep the flight crew pairing the same so as to take advantage of the **pre-existing familiarity**. Hence, such a relationship becomes helpful to pick out relation tuples which have already travelled on a route together. However, it is also customary to **pair a less experienced crew member with a more experienced team** in general to generate a better induction experience. One must also note that it is the Captain who makes all the risky decisions.

Also, in an international flight, it is often preferred to have a crew which all in all **speaks multiple languages** and hence, pairing someone speaking French to someone speaking German is definitely advantageous. Also, in case tension develops amongst the team, it is preferred not to involve such crew members together.

This is a **partial participation** from all entities as a particular crew member may have been newly recruited and may not have been involved in any flight yet.

Relationship attributes	Constraints	Attribute type	Description
Avg. Competence rating	Number between 0 to 10	Single	
Languages spoken overall	Must be a Valid language	Multivalued	
Feedback given by the passengers for his crew	Composite attribute composed of Passenger Boarding Pass ID and a string containing the comment given	Multivalued	Eg: {Boarding Pass 13233232: The crew was welcoming and I had a nice experience}, {Boarding pass 38383333:The pilots seemed to have some disagreement with the flight attendants and this made me nervous}

➤ **PASSENGER (infected individual) has come in contact with PASSENGER (individual at risk)**

This is also a **recursive relationship** which is important in the current COVID-scenario where all passengers who have boarded a particular flight have to be considered to have come in contact with other passengers of the same flight and hence, stand at risk of being infected if one of them tests positive in the future.

FUNCTIONAL REQUIREMENTS

OPERATIONS ON DATABASE

Retrieval Operations

A. SELECTION

- Retrieve complete data tuples of PILOTS who work for a particular AIRLINE.
- Retrieve complete data tuples of PASSENGERS who were travelling on a particular crashed flight

B. Projection Query

- Names of all passengers who have WHEELCHAIR ASSISTANCE as a special service in their BOARDING PASS
- NAMES OF ALL AIRLINES whose flight crew is ≥ 50

C. AGGREGATE :

- Find the PILOT who has the maximum number of FLYING HOURS on record.

D. SEARCH

- Search for all PASSENGERS whose name contains "Kumar"

E. ANALYSIS :

- RANK BUSIEST AIRPORTS by number of scheduled flight departures on a particular day
- RANK most used airline by sorting as per the number of boarding passes issued for that airline since data collection began

Modification Operations

F. Insertion Operations(also checking integrity constraint)

- Addition of a new employee [check SSN format]
- Addition of a newly constructed runway [check between 0 and 36]
- Addition of baggage to a particular boarding pass
- Addition of a new aircraft

G. Update Operations

- Update flight status information based on time delay
- Update statistics regarding total number of kms travelled by airplane, total number of flying hours of a pilot
- Update status of runway

H. Delete Operations

- Deletion of a plane which is no longer active
- Deletion of an inactive/fired employee

By Team Sequel Extract

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