NTNU

Kunnskap for en bedre verden

TDT4145 - Databasemodellering og databasesystemer

Project Assignment - Part 1

Group number 117

Erik Alexander Standal

Sigve Smedshammer

Torstein Pundsnes

10.03.2025

1 Entity Relationship diagram

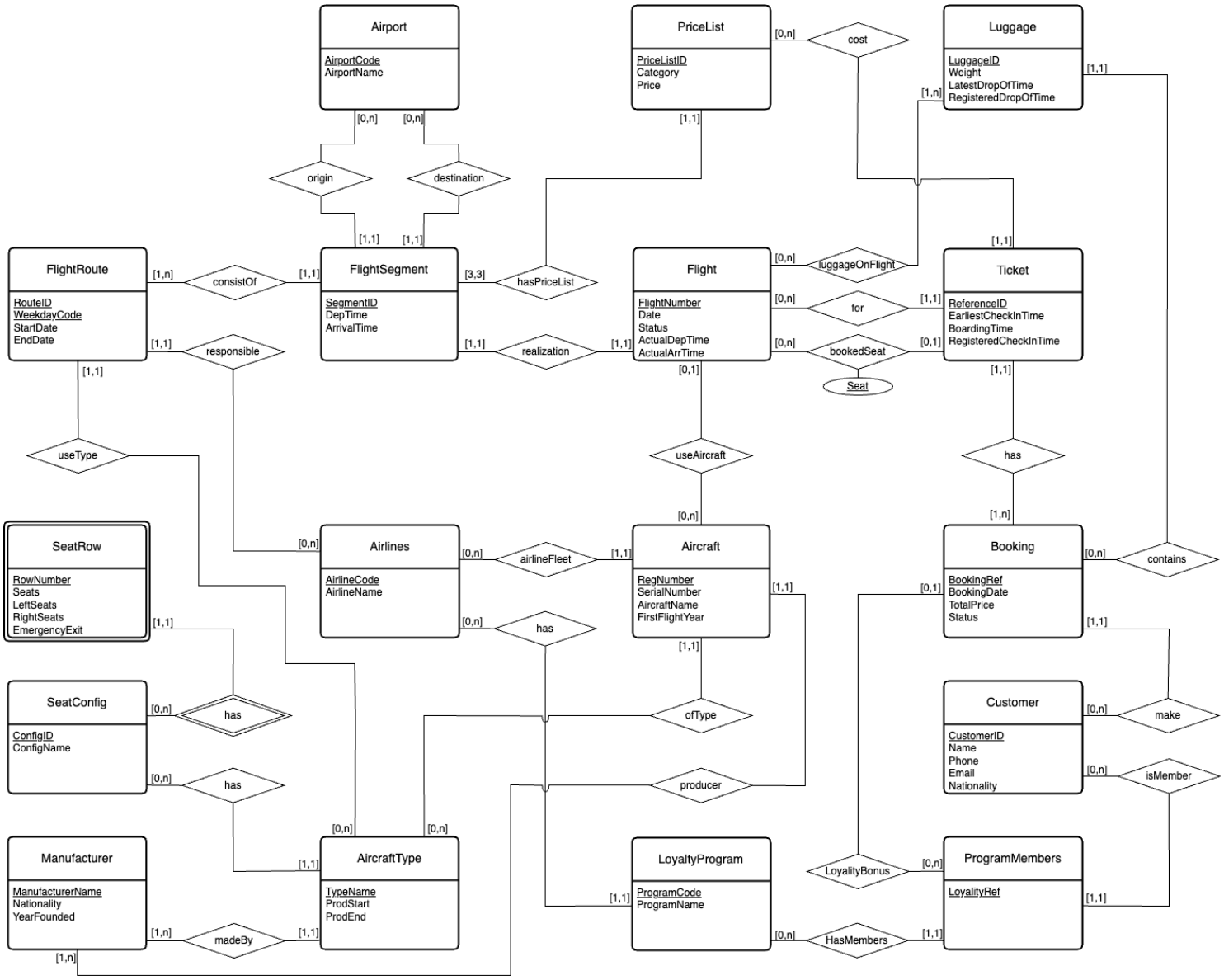

Figure 1: Entity Relationship diagram for project

2 Relational database schema

Note: All tables in this report comply with First Normal Form (1NF). This means each table contains only atomic values, with no repeating groups or arrays, ensuring that every field holds a single piece of data.

Airline (AirlineCode, AirlineName)

> **NF note:** The Airline table is in 2NF because AirlineName fully depends on its candidate key (AirlineCode), in 3NF as there are no transitive dependencies, in BCNF since every determinant is a candidate key, and in 4NF since it has no nontrivial multivalued dependencies.

Manufacturer (ManufacturerName, Nationality, YearFounded)

> **NF note:** The Manufacturer table is in 2NF because both Nationality and YearFounded fully depend on its candidate key (ManufacturerName), in 3NF as there are no transitive dependencies, in BCNF since every determinant is a candidate key, and in 4NF since it has no nontrivial multivalued dependencies.

AircraftType (TypeName, ManufacturerName, ProdStart, ProdEnd, ConfigID)

- ManufacturerName is FK to Manufacturer, cannot be NULL
- ConfigID is FK to SeatConfig, cannot be NULL

> **NF note:** The AircraftType table is in 2NF because ManufacturerName, ProdStart, ProdEnd, and ConfigID fully depend on its candidate key (TypeName), in 3NF as there are no transitive dependencies, in BCNF since every determinant is a candidate key, and in 4NF since it has no nontrivial multivalued dependencies.

Aircraft (RegNR, SerialNumber, AircraftName, FirstFlightYear, AirlineCode, TypeName, ManufacturerName)

- AirlineCode is FK to Airline, cannot be NULL
- TypeName is FK to AircraftType, cannot be NULL
- ManufacturerName is FK to Manufacturer, cannot be NULL

> **NF note:** The Aircraft table has two candidate keys: RegNR and (ManufacturerName, SerialNumber). However, the functional dependency TypeName $\rightarrow$ ManufacturerName violates BCNF since TypeName is not a candidate key. Consequently, the table is in 2NF and 3NF but not in BCNF, and therefore it cannot be in 4NF. We could have dropped ManufacturerName from the table to achieve 4NF, but to enforce a unique serialnumber within a specific manufacturer, the attribute had to be included.

SeatConfig (ConfigID, ConfigName)

> **NF note:** The SeatConfig table is in 2NF because ConfigName fully depends on its candidate key (ConfigID), in 3NF as there are no transitive dependencies, in BCNF since every determinant is a candidate key, and in 4NF since it has no nontrivial multivalued dependencies.

SeatRow (ConfigID, RowNumber, Seats, LeftSeats, RightSeats, EmergencyExit)

- ConfigID is FK to SeatConfig, cannot be NULL

NF note: The SeatRow table is in 2NF because Seats, LeftSeats, RightSeats, and EmergencyExit fully depend on its composite candidate key (ConfigID, RowNumber), in 3NF as there are no transitive dependencies, in BCNF since every determinant is a candidate key, and in 4NF since it has no nontrivial multivalued dependencies.

Airport (AirportCode, AirportName)

NF note: The Airport table is in 2NF because AirportName fully depends on its candidate key (AirportCode), in 3NF as there are no transitive dependencies, in BCNF since every determinant is a candidate key, and in 4NF since it has no nontrivial multivalued dependencies.

FlightRoute (RouteID, WeekdayCode, AirlineCode, StartDate, EndDate, TypeName)

- AirlineCode is FK to Airline, cannot be NULL
- TypeName is FK to AircraftType, cannot be NULL

NF note: The FlightRoute table is in 2NF because AirlineCode, StartDate, EndDate, and TypeName fully depend on its composite candidate key (RouteID, WeekdayCode), in 3NF as there are no transitive dependencies, in BCNF since every determinant is a candidate key, and in 4NF since it has no nontrivial multivalued dependencies.

FlightSegment (SegmentID, RouteID, WeekdayCode, Origin, Destination, DepartureTime, ArrivalTime)

- RouteID, WeekdayCode is FK to FlightRoute, cannot be NULL
- Origin is FK to AirportCode, cannot be NULL
- Destination is FK to AirportCode, cannot be NULL

NF note: The FlightSegment table is in 2NF because RouteID, WeekdayCode, Origin, Destination, DepartureTime, and ArrivalTime fully depend on its candidate key (SegmentID), in 3NF as there are no transitive dependencies, in BCNF since every determinant is a candidate key, and in 4NF since it has no nontrivial multivalued dependencies.

Flight (FlightNumber, RegNR, SegmentID, Date, Status, ActualDepartureTime, ActualArrivalTime)

- RegNR is FK to Aircraft, can be NULL
- SegmentID is FK to FlightSegment, cannot be NULL

NF note: The Flight table is in 2NF because RegNR, SegmentID, Date, Status, ActualDepartureTime, and ActualArrivalTime fully depend on its candidate key (FlightNumber), in 3NF as there are no transitive dependencies, in BCNF since every determinant is a candidate key, and in 4NF since it has no nontrivial multivalued dependencies.

BookedSeat (FlightNumber, Seat, TicketID)

- FlightNumber is FK to Flight, cannot be NULL
- TicketID is FK to Ticket, cannot be NULL

NF note: Since all attributes form the candidate key, the table trivially satisfies 2NF, 3NF, BCNF, and 4NF.

Customer (CustomerID, Name, Phone, Email, Nationality)

NF note: The Customer table is in 2NF because all non-key attributes (Name, Phone, Email and Nationality) fully depend on its candidate key (CustomerID), in 3NF as there are no transitive dependencies, in BCNF since every determinant is a candidate key, and in 4NF since it has no nontrivial multivalued dependencies.

Booking (BookingRef, CustomerID, LoyaltyRef, BookingDate, TotalPrice, Status)

- CustomerID is FK to Customer, cannot be NULL
- LoyaltyRef is FK to LoyaltyProgram, can be NULL

NF note: The Booking table is in 2NF because CustomerID, LoyaltyRef, BookingDate, TotalPrice, and Status fully depend on its candidate key (BookingRef), in 3NF as there are no transitive dependencies, in BCNF since every determinant is a candidate key, and in 4NF since it has no nontrivial multivalued dependencies.

PriceList (PriceListID, Category, Price, SegmentID)

- SegmentID is FK to FlightSegment, cannot be NULL

NF note: The PriceList table is in 2NF because all non-key attributes (Category, Price, SegmentID) fully depend on its candidate key (PriceListID), in 3NF as there are no transitive dependencies, in BCNF since every determinant is a candidate key, and in 4NF since it has no nontrivial multivalued dependencies.

Ticket (TicketID, FlightNumber, PriceListID, BoardingTime, EarliestCheckInTime, Registered-CheckInTime, BookingID)

- FlightNumber is FK to Flight, cannot be NULL
- PriceListID is FK to PriceList, cannot be NULL
- BookingID is FK to Booking, cannot be NULL

NF note: The Ticket table is in 2NF because FlightNumber, PriceListID, BoardingTime, EarliestCheckInTime, RegisteredCheckInTime, and BookingID fully depend on its candidate key (TicketID), in 3NF as there are no transitive dependencies, in BCNF since every determinant is a candidate key, and in 4NF since it has no nontrivial multivalued dependencies.

AirportHasIncomingRoute (AirportCode, SegmentID)

- AirportCode is FK to Airport, cannot be NULL
- SegmentID is FK to FlightSegment, cannot be NULL

NF note: Since both attributes form the candidate key, the table trivially satisfies 2NF, 3NF, BCNF, and 4NF.

AirportHasOutgoingRoute (AirportCode, SegmentID)

- AirportCode is FK to Airport, cannot be NULL
- SegmentID is FK to FlightSegment, cannot be NULL

NF note: Since both attributes form the candidate key, the table trivially satisfies 2NF, 3NF, BCNF, and 4NF.

LoyaltyProgram (ProgramCode, AirlineCode, ProgramName)

- AirlineCode is FK to Airline, cannot be NULL

  NF note: The LoyaltyProgram table is in 2NF because AirlineCode and ProgramName fully depend on its candidate key (ProgramCode), in 3NF as there are no transitive dependencies, in BCNF since every determinant is a candidate key, and in 4NF since it has no nontrivial multivalued dependencies.

ProgramMembers (LoyaltyRef, ProgramCode, CustomerID)

- ProgramCode is FK to LoyaltyProgram, cannot be NULL
- CustomerID is FK to Customer, cannot be NULL

  NF note: The ProgramMembers table is in 2NF because ProgramCode and CustomerID fully depend on its candidate key (LoyaltyRef), in 3NF as there are no transitive dependencies, in BCNF since every determinant is a candidate key, and in 4NF since it has no nontrivial multivalued dependencies.

Luggage (LuggageID, BookingRef, Weight, LatestDropOfTime, RegisteredDropOfTime)

- BookingRef is FK to Booking, cannot be NULL

  NF note: The Luggage table is in 2NF because BookingRef, Weight, LatestDropOfTime, and RegisteredDropOfTime fully depend on its candidate key (LuggageID), in 3NF as there are no transitive dependencies, in BCNF since every determinant is a candidate key, and in 4NF since it has no nontrivial multivalued dependencies.

LuggageOnFlight (LuggageID, FlightNumber)

- LuggageID is FK to Luggage, cannot be NULL
- FlightNumber is FK to Flight, cannot be NULL

  NF note: Since both attributes form the candidate key, the table trivially satisfies 2NF, 3NF, BCNF, and 4NF.

3 Assumptions

- Assume that a Manufacturer must have at least one type of AircraftType in production.
- Assume that an AircraftType has only one Manufacturer.
- Assume that an Airline can have multiple loyalty programs (e.g. Silver, Gold, Platinum).
- Assume that a seat configuration can be shared among multiple aircrafts.
- Assume that there can be n pieces of luggage per booking.

4 Software restrictions

- If no seat is chosen during booking, it will be automatically assigned at check-in.
- Need to assign the cheapest price when booking a multi-legged flight route. E.g if a route consists of two legs and has a cheaper price if you fly the whole route this price will be used for the ticket price
- When booking a flight we need to make sure that only valid loyalty-programs can be used for the flight. E.g a SAS bonus can't be used on a Norwegian flight.