ECS519U
Database Systems Coursework 2: Eurostar-Scenario

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Background information:

Eurostar, a high-speed rail service that launched on 14th November 1994, connects the countries Belgium France, United Kingdom, and the Netherlands which includes 13 different destinations between them. However, majority of Eurostar trains are between France and the United Kingdom travelling through the Channel Tunnel. Eurostar have 15 trips, Paris-London on weekdays excluding Fridays, which consists of 19. Additionally, they also offer non-stop services although they are charged at a higher price. There are many other service routes Eurostar offers, such as London-Brussels and London-Marne-la-Vallée. Seasonal services are included by Eurostar, such as increased services to Disneyland during holiday periods and "Snow trains", which are aimed at skiers, to places in the Alps.

Over 200 million passengers have travelled with Eurostar since launch, which is more than the total population of all the countries it connects combined. Eurostar controls 80% of the market share being the direct travel market. At launch, London to paris took 3 hours whereas now it only takes 2 hours and 16 minutes. When Eurostar launched, a ticket from paris would've cost £95 whereas now it starts from £29. These lower prices and faster travel times have ensured that Eurostar attract passengers to use their services whilst holding and increasing their market share in direct travel. A Eurostar train, when fully booked out, can hold up to 900 passengers.

There are 3 different seating types offered by Eurostar: Standard, Standard Premier and Business Premier. Eurostar have given options to satisfy different needs of passengers, however it comes at a costs. The standard travel class allows you to bring along 2 pieces of luggage with a hand luggage. Eurostar also allows passengers to exchange tickets up to 7 days before departure. Similarly, standard premier includes these benefits but offer a light meal and drinks to be served at your seats and extra spacious seats. Business Premier on the other hand offers no exchange fees within 7days, free cancellation, fast-track a three course meal and more comfortable spacious seats. Business Premier prices tend to stay at a static price of £245, which is twice as much as the average price of a Standard Premier tickets and more than 4 times as much as a Standard ticket.

Assumptions:

- Every route can have exactly one final destination and exactly one starting destination
- Every route can have none, one or many stops in between the starting location and the final destination
- A stop in one route can be a final destination or a starting location in another route
- Every route will have different distances in miles and different times taken
- There will be exactly 11 employees on each train. 2 drivers, 2 conductors, 5 service team members and 2 security guards
- Many types of passenger can be on a given train and each train will have varying numbers of passengers
- An employee can work on multiple different crews and have different roles, but for each crew they can only have one role.
- Route times and route distances have a direct relation and are therefore dependant on each other.
- There are numerous trips but only a limited number of routes

ER Model Textual Description:

The ER model shows the relationship and interactions the entities have with each other. Our model has 7 entities which are:

- Train
- Route
- Passenger
- Crew
- Station
- Employee
- Ticket

Our entities have the following attributes:

- Train has (trainType, status, capacity, number of coaches, Length, trainID, isNotOld)
- crew has (crewID, name)
- ticket has (type, price)
- Employee(Employee ID,role, name)
- passenger has (passengerID, Name and type)
- Station has (Station ID, Name,city)
- Route has (route time, route id, route distance, start station, end station, stops, status)

Every entity has been created with a key attribute. This key attribute for our entity relationship model is the entity name followed by ID. This allows every entity to be identified when necessary to increase the uniqueness of the entity. This provides more clarity and accuracy when attempting to retrieve data from the model.

This identifier is most effective when approaching the route and train entities. Although the route entity has a key attribute of route ID, more information is provided by the further attributes of: start station, end station and stop. This will allow users of the DB to know if on a certain route the function of the station changes. This will therefore correspond with the Station ID attribute of the station entity.

The employee entity has an attribute of role which will relate back to the Crew ID This will be beneficial in determining where they work within the train.

Old trains cannot run according to requirements, this is why trains have an attribute of isNotOld to ensure only modern trains run.

The passenger entity has attribute, type, which will relate to whether the passenger may be a young persons or an OAP. This will be the assumption in determining ticket price and type. This consequently explains why ticket entity is a weak entity as it is only in effect for and because of the passenger entity

Train is an entity with one of the most attributes, two of the attributes are number of coaches and train type. Typically in Eurostar trains, they select the train type based on factors like time of travel, route id, capacity. This means the two attributes have a role when determining a passengers ticket type which will therefore be necessary to determine the passengers ticket price which will be a derived attribute as it relies on the type of ticket the passenger has potentially based on the train type used for the route ID. However, in this model the assumption is the ticket price is determined by the passenger type.

Entity relationships

There are 5 relationships within this diagram. These relationships all have cardinality ratios.

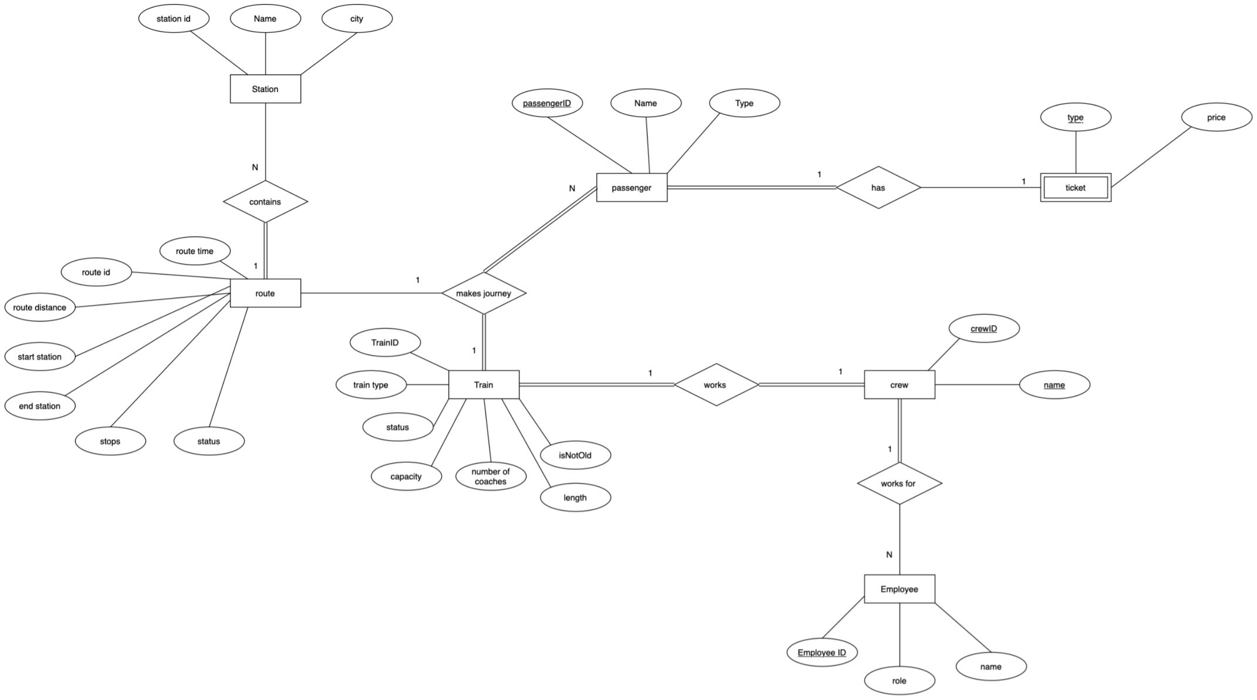
- Has 1:1 (between Passenger and Ticket)
- Works_On 1:1(Crew, Train)
- Takes_journey_for
  - M: N (between Train, Route)
  - 1: N between ((Train, Route) and Passenger)
  - This also has relationship type attributes of departure time and arrival time.

Contains is a relationship between route and station with a 1: N cardinality
Works for is a relationship between employee and crew with a N:1 cardinality
Has is a relationship between passenger and ticket with a 1:1 cardinality
Works is a relationship between crew and train with a 1:1 cardinality
Makes journey is relationship between train and route with a M:N cardinality
Makes journey is a relationship between Train, route and passenger with a 1:N cardinality

The makes_journey is the key central relationship as it connects and associates route,passengers and train entities when making one trip. The relationship has a cardinality ratio of many to many as in this scenario many passengers can make the journey on just one route conversely many routes are can journeyed by one passenger. Or many trains can can journey one route and many routes can be journeyed by one train.

The works_for relationship is between the employee entity and crew entity. Crews have many employees.

ER Diagram:



Normalisation:

1st Normal Form

In the Route table, there is a column called Stations which lets us see each station that is visited in a given route. The problem lies with the fact that each route can potentially have several stations between them, creating a nested model, which is not allowed for a schema to be in first normal form. The solution to this, is to create a new Stations table:

ID	Order	RouteID	StationId
1	2	1	1
2	3	1	2
3	1	1	3

This would avoid the nesting issue by using StationID and RouteID as foreign keys, so that every station visited can be stored for a given order and route. The end result being that the Route table would become : Route (Route ID, RouteTime, RouteDistance, Status)

2nd Normal Form

As stated in the assumptions above, an employee can work on multiple different crews and have different roles, but for each crew they can only have one role. If we have a look at the Employee table the candidate key would be the EmployeeID and the CrewID together. The non-prime attribute Role has a functional dependency on the Crew it belongs to and therefore the CrewID. There is nothing stopping us from adding a new employee who works for the same crew and is also a head conductor but there can only be one head conductor. For a schema to be in 2nd normal form all non-prime attributes must not be functionally dependent on any subset of the candidate key. Therefore, this schema is not in second normal form.

To normalise we can separate this functional dependency by adding jobs as attributes to the Crew table taking values as employee ID's and removing the Role attribute from employee. This would leave the tables as the following:
Crew (CrewID, CrewName, Driver1, Driver2, HeadConductor, SecondConductor, SecurityGuard1, SecurityGuard2, Service Member)
Employee (EmployeeID, CrewID, Name)

3rd Normal Form

Due to the aforementioned assumption that route time and route distance are dependent on each other, our route table would not be in 3rd normal form as both route time and route distance are are non-prime attributes and for a schema to be in 3rd normal form, all non-prime attributes must have no dependencies between other non-prime attributes. which depend on one another. We can again normalise by separating out the functional dependency through creating another new table with a primary key of RouteDistance and a RouteTime. This would leave the final tables as the following:
Distance (RouteDistance, RouteTime, FuelRequired)
Route (RouteID, RouteDistance, OperatingStatus)