Database Systems

Tutorial Week 4

Objectives

I. Additional concepts in ER modelling, plus a simple case study

II. Bus company case study — conceptual and logical modelling

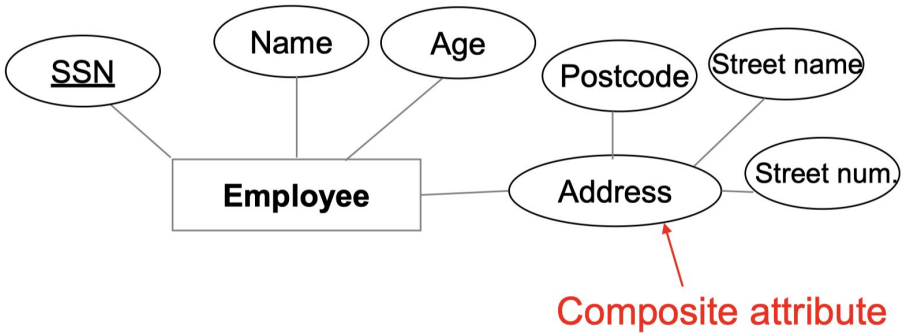
Entity-Relationship (ER) Modelling Review

Attributes:

- Information about an entity e.g. ID, date of birth

Composite attribute:

- An attribute composed of smaller ones e.g.



Entity-Relationship (ER) Modelling Review

Attributes:

- Information about an entity e.g. ID, date of birth

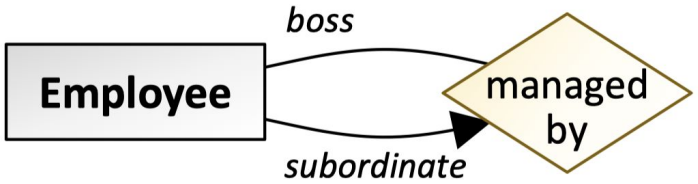
Multi-valued attribute:

- Can take multiple values of the same type e.g. phone number
- Drawn using a double outline

Entity-Relationship (ER) Modelling Review

Unary relationships:

- Relationship between an entity and itself
- Like binary relationships, they can have different constraints
- Employee is managed by at most 1 other employee, and employee can manage 0 or more employees

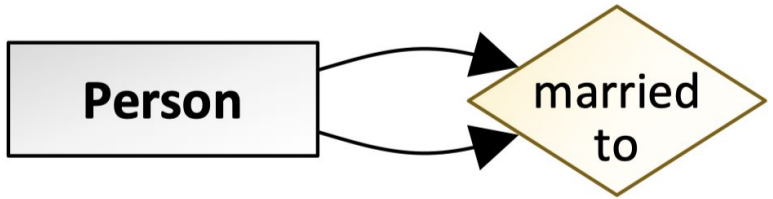


One-to-many unary relationship

Entity-Relationship (ER) Modelling Review

Unary relationships:

- Relationship between an entity and itself
- Like binary relationships, they can have different constraints
- Person is married to at most one other person

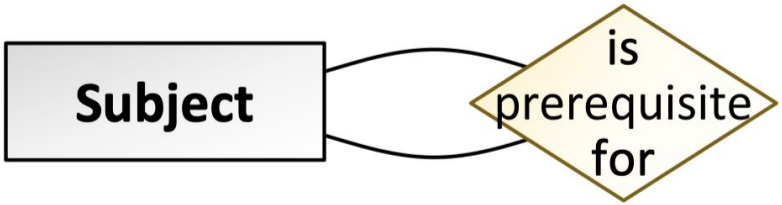


One-to-one unary relationship

Entity-Relationship (ER) Modelling Review

Unary relationships:

- Relationship between an entity and itself
- Like binary relationships, they can have different constraints
- Subject may be a prerequisite for many subjects



Many-to-many unary relationship

Entity-Relationship (ER) Modelling Review

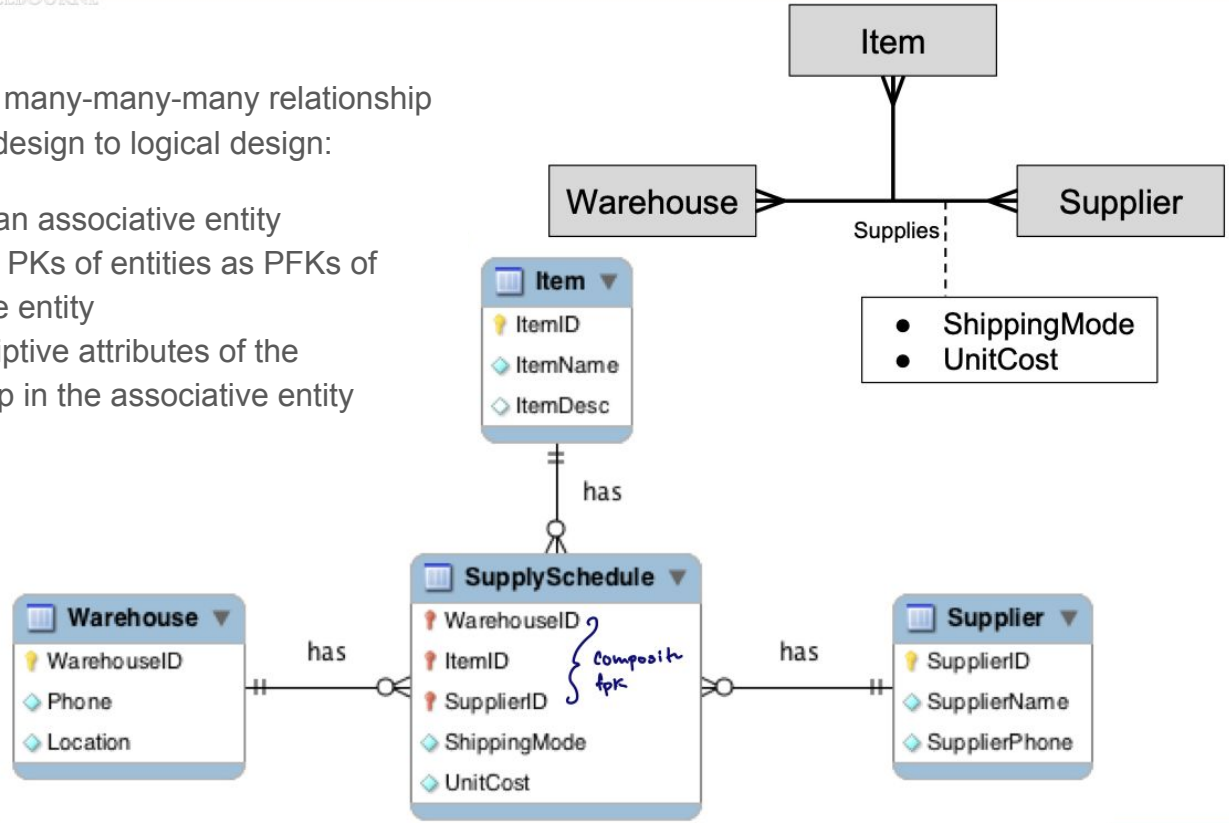
Ternary relationships:

- Relationship between 3 entities
- Often many-many-many relationship

Ternary relationships: Many to Many

When converting many-many-many relationship from conceptual design to logical design:

- Generate an associative entity
- Propagate PKs of entities as PFKs of associative entity
- Add descriptive attributes of the relationship in the associative entity



Let’s Practise These Concepts

Use the following information to model a “company” entity using Chen’s notation. (6 mins)

Australia’s corporate regulator, ASIC, stores a range of information about companies, including the name, the nine-digit ACN (Australian Company Number), the date of registration and deregistration, and the names of the company’s directors. Every company has a registered address, made up of the street address, suburb, state and postcode. A company may be owned by another company; in this situation ASIC keeps track of the company’s parent company.

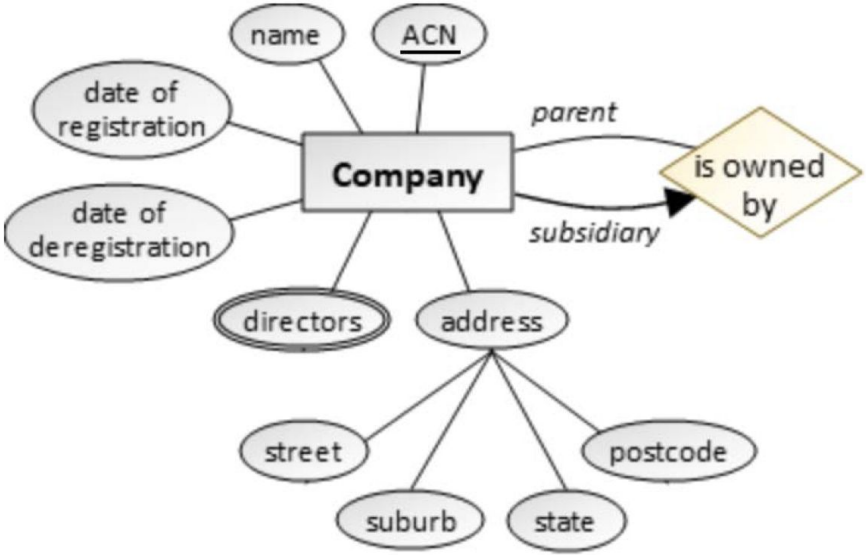
Let’s Practise These Concepts

Use the following information to model a “company” entity using Chen’s notation.

- Attributes: name, ACN, date of registration, date of deregistration
- Company can have one or more directors, so directors’ names is a multivalued attribute
- Address is composed of several parts (street address, suburb, state, postcode) so is a composite attribute
- Unary relationship between a company and its parent company
    - Each company may have a parent company (partial participation, “one”)
    - Every company may own zero or more companies (partial participation, “many”)

Let’s Practise These Concepts

Use the following information to model a “company” entity using Chen’s notation.



Another Case Study — ER Modelling

A bus company owns a number of buses. Each bus is allocated to a particular route, although some routes may have several buses. Each route passes through a number of towns. One or more drivers are allocated to each stage of a route, which corresponds to a journey through some or all of the towns on a route. Some of the towns have a depot where buses are kept – each bus always returns to its allocated depot at the end of the day.

Each of the buses is identified by its registration number and can carry different numbers of passengers, since the vehicles vary in size and can be single or double-decked. Each route is identified by a route number and information is available on the average number of passengers carried per day for each route. Drivers have an employee number, name, address, and sometimes a telephone number, and the names of the training courses they have completed need to be stored.

Another Case Study — ER Modelling

15 mins:

a. Identify the **entities**.
b. Identify the **relationships** (use business rules to identify relationships). State all the **key constraints** and **participation constraints**.
c. Draw a conceptual model and populate entities with appropriate **attributes** (use Chen's notation).

   Don't forget to mark **weak entities**, **identifying relationships** and **key attributes**.

d. Discuss the **logical modelling** of the Driver entity.

Another Case Study!

a. Identify the **entities**.

A bus company owns a number of buses. Each bus is allocated to a particular route, although some routes may have several buses. Each route passes through a number of towns. One or more drivers are allocated to each stage of a route, which corresponds to a journey through some or all of the towns on a route. Some of the towns have a depot where buses are kept – each bus always returns to its allocated depot at the end of the day.

Another Case Study!

a. Identify the **entities**.

- Bus
- Route
- Town
- Driver
- Stage
- Depot

Another Case Study — ER Modelling

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Another Case Study!

a. Identify the **entities**.
b. Identify the **relationships** (use business rules to identify relationships). State all the **key constraints** and **participation constraints**.

“One or more drivers are allocated to each stage…”

- Relationship: driver “allocated to” stage
- Many-to-many
- Participation of Driver is **partial** — accommodates newly appointed or on-leave drivers
- Participation of Stage is **total** — each stage must be allocated a driver

Another Case Study!

a. Identify the **entities**.
b. Identify the **relationships** (use business rules to identify relationships). State all the **key constraints** and **participation constraints**.

"… each stage of a route… corresponds to a journey through some or all of the towns on a route."

- Relationship: stage "part of" route
- One-to-many
- Participation of Stage is **total** — every route must have a stage
- Participation of Route is **total** — every stage must belong to a route

Another Case Study!

a. Identify the **entities**.
b. Identify the **relationships** (use business rules to identify relationships). State all the **key constraints** and **participation constraints**.

“… each stage of a route… corresponds to a journey through some or all of the towns on a route.”

- Relationship: stage “passes through” town
- Many-to-many
- Participation of Stage is **total** — a stage has to pass through a town
- Participation of Town is **partial** — a town may not be part of any stage (it might only have a depot)

Another Case Study!

a. Identify the **entities**.
b. Identify the **relationships** (use business rules to identify relationships). State all the **key constraints** and **participation constraints**.

“Each bus is allocated to a particular route, although some routes may have several buses.”

- Relationship: route “operated by” bus
- One-to-many
- Participation of Route is **total** — every route should have a bus assigned
- Participation of Bus is **partial** — a bus could be under repair

Another Case Study!

a. Identify the **entities**.
b. Identify the **relationships** (use business rules to identify relationships). State all the **key constraints** and **participation constraints**.

"… depot [is] where buses are kept – each bus always returns to its allocated depot at the end of the day"

- Relationship: bus "allocated to" depot
- One-to-many
- Participation of Bus is **total** — each bus is allocated to a depot
- Participation of Depot is **partial** — a depot may not have any busses allocated to it

Another Case Study!

a. Identify the **entities**.
b. Identify the **relationships** (use business rules to identify relationships). State all the **key constraints** and **participation constraints**.

“Some of the towns have a depot…”

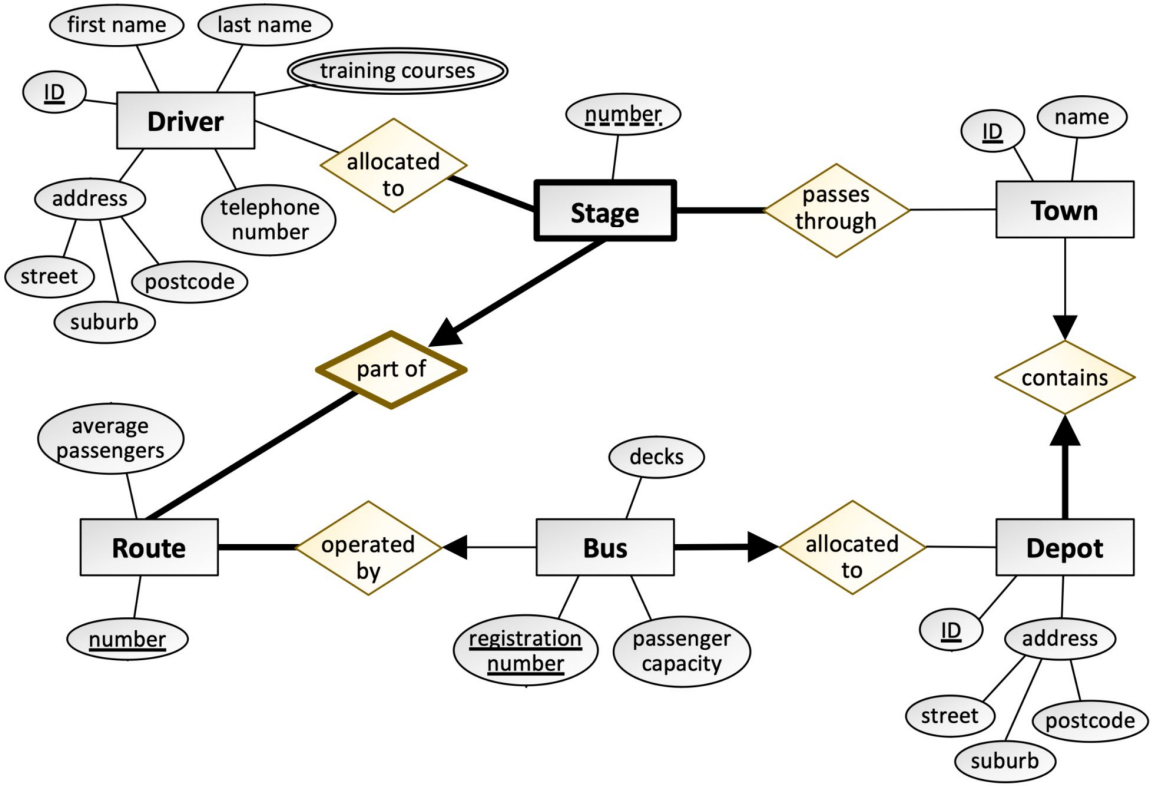
- Relationship: town “contains” depot
- One-to-one
- Participation of Town is **partial** — only some towns have a depot
- Participation of Depot is **total** — depot has to be in a town

Another Case Study!

a. Identify the **entities**.
b. Identify the **relationships** (use business rules to identify relationships). State all the **key constraints** and **participation constraints**.

- Route “operated by” bus
- Driver “allocated to” stage
- Stage “part of” route
- Stage “passes through” town
- Town “contains” depot
- Bus “allocated to” depot

Another Case Study!



Another Case Study!

a. Identify the **entities**.
b. Identify the **relationships** (use business rules to identify relationships). State all the **key constraints** and **participation constraints**.
c. Draw a conceptual model and populate entities with appropriate **attributes** (use Chen's notation).
d. Discuss the **logical modelling** of the Driver entity.

Another Case Study!

Recall:

Conceptual ER model → logical design:

- **Resolve composite attributes**
- **Resolve multivalued attributes**
- Resolve relationships by adding **foreign keys** and **associative entities** to the model, and placing **relationship attributes** in the correct location

- Also at this stage, names are conventionally changed into CamelCase
  e.g. “seating capacity” → “SeatingCapacity”

Another Case Study!

3 mins:

a. Identify the **entities**.
b. Identify the **relationships** (use business rules to identify relationships). State all the **key constraints** and **participation constraints**.
c. Draw a conceptual model and populate entities with appropriate **attributes** (use Chen's notation).
d. Discuss the **logical modelling** of the Driver entity.

We can use this notation:
Employee (ssn, name, age)

Another Case Study!

- Resolve composite attributes:
  - Add component parts directly to the entity
  - The composite “address” attribute on Driver is resolved like this:
    Driver (DriverID, FirstName, LastName, AddressStreet, AddressSuburb, AddressPostcode, PhoneNumber)
  - Depot address is resolved similarly

Another Case Study!

- Resolve multivalued attributes:
  - Can be resolved in two ways
  - If you have a small number of distinct values (e.g. phone → work phone, home phone and mobile phone), you can resolve it in the same way as a composite attribute
  - If the number of values is unlimited, resolve by creating a lookup table
    - Create a new table with a primary foreign key referring to the PK of the table with the multivalued attribute
    - Create a primary key column that will contain each attribute value
  - No limit to the number of training courses a driver can take, so resolve “training courses” multivalued attribute by creating a new DriverTrainingCourses table:

FK

DriverTrainingCourses (DriverID, TrainingCourseName)

Another Case Study!

Final logical design of Driver:

Driver (DriverID, FirstName, LastName, AddressStreet, AddressSuburb, AddressPostcode, PhoneNumber)

DriverTrainingCourses (DriverID, TrainingCourseName)

FK

Another Case Study!

Logical design for remaining tables, after resolving all relationships:

DriverAllocatedToStage (FK DriverID, FK RouteNumber, FK StageNumber)

Stage (FK RouteNumber, StageNumber)

Town (TownID, TownName)

StagePassesThroughTown (FK TownID, FK RouteNumber, FK StageNumber)

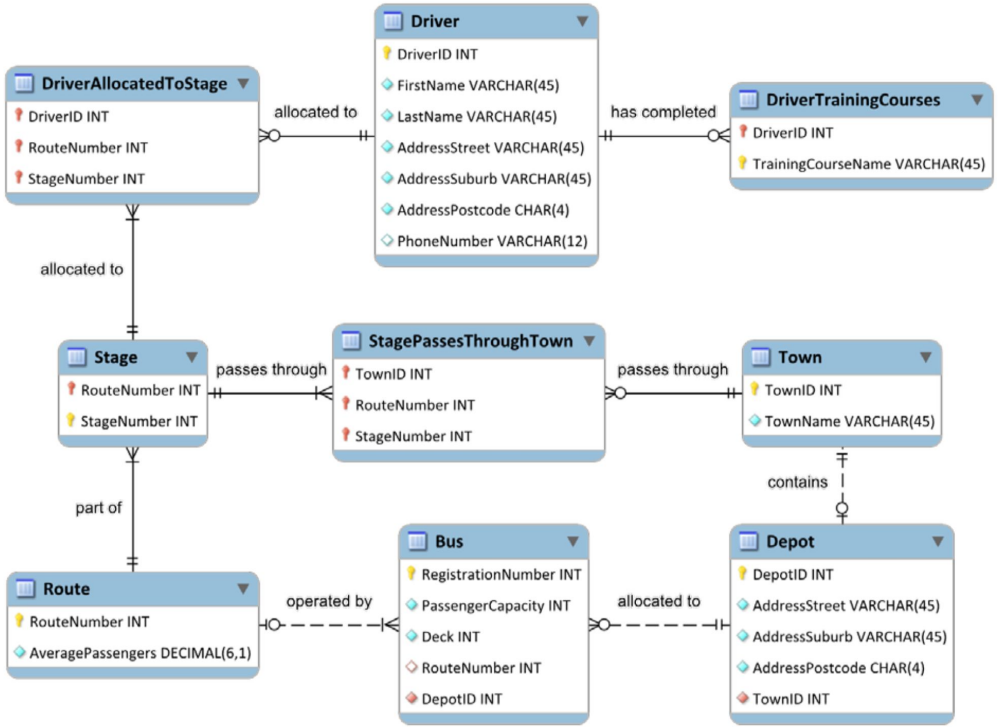
Route (RouteNumber, AveragePassengers)

Bus (RegistrationNumber, PassengerCapacity, Make, Deck, FK RouteNumber, FK DepotID)

Depot (DepotID, AddressStreet, AddressSuburb, AddressPostcode, FK TownID)

Another Case Study!

Physical model:



Week 4 Lab

- Canvas → Modules → Week 4 → Lab → L04 Modelling 3 (PDF)
- Objectives:
  - Design an ER model
  - Forward engineer the ER design to SQL
  - Prepare the schema for next week's lab
- Breakout rooms, "ask for help" button if you need help or have any questions