

# Relational Database Systems Lecture 2

## Conceptual Modelling

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## Aim of Lecture

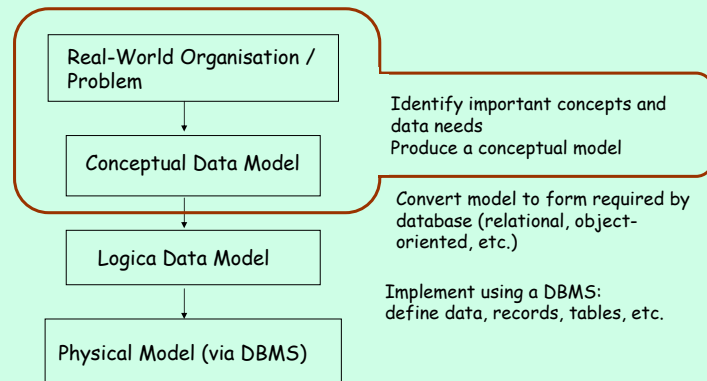
- Outline the steps involved in designing a database
- Explain the first phase: *Conceptual Modelling*
- Study a particular conceptual model: the Entity Relationship model
  
- By the end you should be able to
  - Explain what conceptual design is, and how it is used
  - Represent a real-world situation as an Entity Relationship Model
  - Understand an ER model constructed by someone else

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## Role of Conceptual Modelling within the design process



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## The Conceptual Data Model

- Abstract view of situation
  - Includes the important elements  
Library: Books, Members, ~~Carpets~~
  - Uses human terms, not computer terms  
Member borrows Book, Platform is in Location  
~~Tables~~, ~~Combo Boxes~~, ~~Foreign Keys~~...
  - Useful for discussion with clients
  - One form is the Entity-Relationship model
  - Basis for the next step: the logical model

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## Conceptual Data Model continued

- There are different formalisms for the conceptual data model:
  - Entity Relationship Model
  - Semantic Object Model
    - Similar approach, but more complex
    - Defines Classes instead of Entities
    - Different types of Classes
      - Concrete, Abstract, Aggregate
    - Different types of Properties
      - Optional/mandatory, simple/compound, single-valued/multi-valued, ....

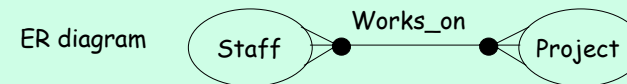
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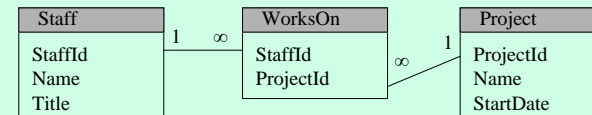
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## Why bother with ER modelling? (1)

Suppose we wish to record details of staff working on projects...



Tables



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## Why bother with ER modelling? (2)

- ER model is simpler and easier to understand
  - Makes your life easier
  - Helps discussions with customers and fellow-workers
- It allows you to work on *one task at a time*
  1. Modelling the real-world situation
  2. Designing the DB tables
- Most large organisations will require it

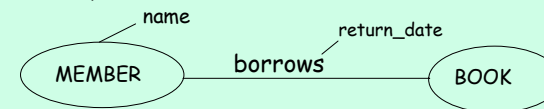
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## Very Simple Example of an ER model A library

- Entities
  - BOOK, MEMBER
- Attributes
  - BOOK(title, author, ISBN,...)
  - MEMBER(name, address, phone#, ...)
- Relationships



Functionality of relationship

A member can borrow between 0 and 6 books

A book can be borrowed by between 0 and 1 members

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## The Entity-Relationship Model (1)

- **Entity:** A Thing
  - Capable of independent existence
  - Can be uniquely identified
  - Often correspond to nouns
    - **Managers** manage **Projects**
    - **Equipment** is made up of **Parts**
- **Attributes:** Properties of an entity
  - Projects have a **start-date**
  - Students have a **name**, **sex** and **student-id**

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## Find the entities and attributes

### Entity Attribute

"We need a database to track the movement of stock items. Each item has a code number and comes from a particular supplier. Each item can be used on one of many platforms. Each platform has a name and location".

"Each supplier has an id code, name, address and phone number".

"Each location has a latitude, longitude, and sea area name".

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## The Entity-Relationship Model (2)

- **Entity type** = entity name plus attributes
  - Completely defines the entity
  - E.g. **Student(Name, Sex, Student-ID)**
- **Entity Instance** = An occurrence of a given entity type
  - E.g. **Angus Maclean, Male, 0102334**
- **Domain** = Range of Values an attribute can have
  - Sex is **male or female**
  - Age is an **integer**
  - Title is **"Mr", "Mrs" or "Ms"**
  - Driver code is **a string consisting of "D" followed by 3 digits**

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## The Entity-Relationship Model (3)

- **Attribute Type** = which domain an attribute is in
  - The domain of **sex** is {"male", "female" }
  - Attribute gender of patient has type **sex**
- **Multi-valued attribute**
  - **Degrees-held** might have value (BA, MSc, PhD)
  - Avoid multi-valued attributes!
- **Composite attribute**
  - An attribute with a fixed number of parts
  - (**Given-Name, Family-Name**)

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## NULLS

- Attributes may have value "Null"
- This means value is either unknown or inapplicable
  - Driving Licence Number (if you don't drive)
  - Highest level of education (if no education)

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## The Entity-Relationship Model (4)

- **Candidate Key**: an attribute or group of attributes which
  - uniquely identifies instances of a given entity
  - for example
    - **Student-ID** identifies a Student
    - **Driver-Code** identifies a Driver
    - **Surname** does NOT identify a student
    - **(Given-Name, Surname)** does NOT identify a student either

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## The Entity-Relationship Model (5)

- **Candidate Key**: an attribute or group of attributes which
  - uniquely identifies instances of a given entity
  - and
    - loses that property if an attribute is removed
    - is minimal/irreducible
  - For example
    - **(Student-ID, National Insurance Number)** is NOT a candidate key for RGU students, because either Student-ID OR National Insurance Number is a unique identifier on its own.

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## Relationships

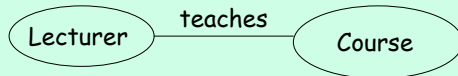
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## The Entity-Relationship Model (6)

- **Relationship:** a named association between two sets of entities
  - Often correspond to verbs
  - Lecturer **teaches** Course
  - Person **borrow**s Book

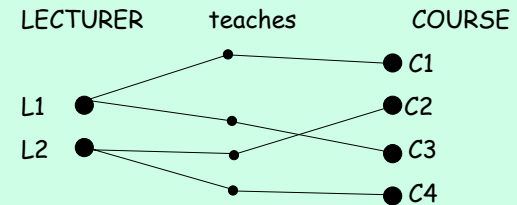


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## Relationships via the Occurrence diagram



Each lecturer can teach many courses, but each course has just one lecturer

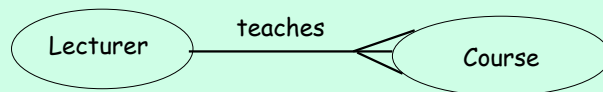
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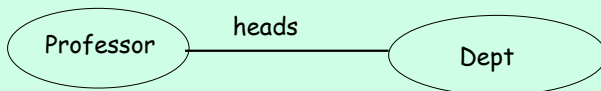
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## Relationships in Bachman notation

Each lecturer can teach many courses, but each course has just one lecturer



Each professor heads one dept., and each dept has one professor as head.

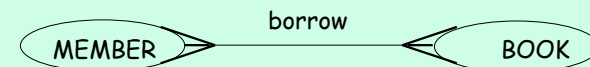
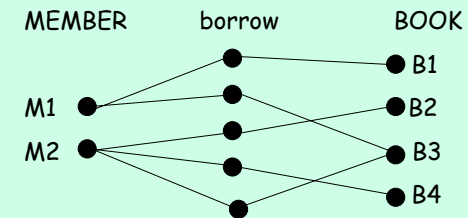


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## Many to Many Relationships

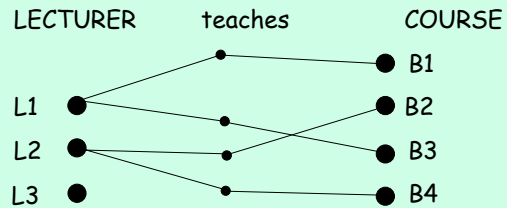


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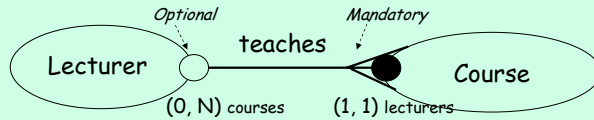
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## Membership class



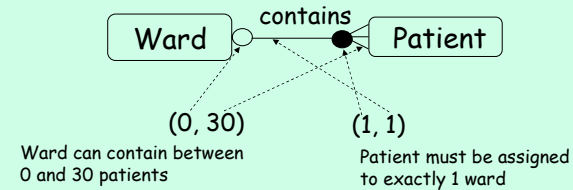
Each course must have a lecturer. Each lecturer may teach many courses, or none



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## Bachman Notation - Example

A ward can contain between 0 and 30 patients  
A patient must be assigned to exactly 1 ward

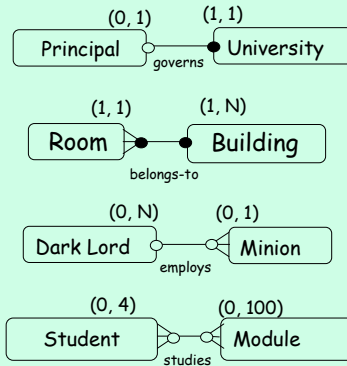


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## More examples of Bachman Notation



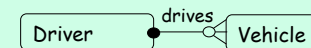
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## Exercise 1

- Entities are Driver and Vehicle.
- Driver *drives* vehicle
- Each driver has at least one vehicle; he may have many
- Each vehicle has at most one driver; it may have none



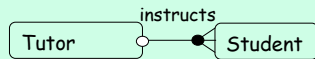
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## Exercise 2

- Entities are Student and Tutor
- Tutor *instructs* Student
- Each tutor can instruct many Students, or he may have no Students
- Each student has exactly one tutor



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## The Complete ER Model

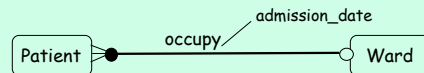
- A complete ER model consists of
  1. An ER diagram
  2. Definition of entities, with attributes and identifiers defined
  3. Relationship definitions with attributes
  4. Discussion of constraints and assumptions

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## Complete ER Model



Entities: Patient(patient-id, patient-name, tel, ward)  
Ward(ward-no, ward-name)

Attribute	Comment	Domain	Example
patient-id	Primary Key	Pnnn	P123
patient-name		12 chars	Tommy Atkins
...			

Relationships: occupy(admission-date)

Attribute	Comment	Domain	Example
admission-date	Date admitted	dd/mm/yy	11/11/59

Constraints/Assumptions: Each patient must be assigned to a ward. Each ward can hold up to 30 patients, and may be empty.

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## A situation can have different models

"A library loans books to members"

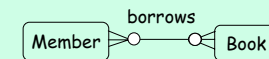
Model 1: One single Loan entity with many attributes

Loans(L#, M#, B#, member\_name, mem\_address, title, author, date\_out, ...)

Problems: Only stores info on books checked out  
Duplicates some information

Model 2: Two entities and one relationship

Member(M#, member\_name, address, ...)  
Book(B#, title, author, date\_out, ...)



Model 3: Three entities and two relationships

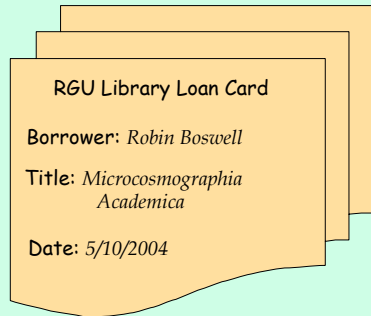
Member(M#, member\_name, address, ...)  
Book(B#, title, author, ...)  
Loan\_card(L#, date\_out, date\_due)

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## Book borrowing using loan cards



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## Exercise 3

Member fills\_in Card (and may fill in many cards)

Card refers\_to book

A book may have many cards (since it can be borrowed many times, if we record past borrowings)

Draw the ER diagram for the third ER model, where loan cards are used to borrow book.

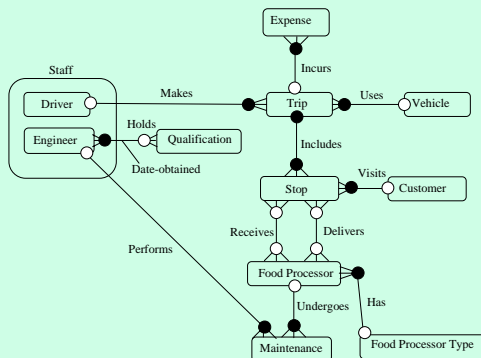


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## Example of more realistic ER diagram



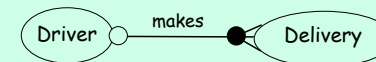
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## Summary

- An entity relationship model
  - Represents the important features of a situation
  - Is independent of which kind of logical model, if any, you plan to transform it into
  - Contains entities, attributes and relationships
  - Can be represented graphically using the Bachman notation



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