Modelling

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1   E-R models

An Entity-Relationship Model represents the data requirements for a system.

> **E-R models should help**
> - It is important to note that ER models are a tool, not a rule.
> - Just like language, the same system may be adequately described by multiple differing ER models which are all equally valid.

1.1   Diagrammatic forms

An Entity-Relationship Diagram is a **visual presentation** of the entity-relationship model for a system.

> ### E-R diagram types
> There are several different styles of diagram used:
> **Crow's foot** named due to similarity of the "many" symbol to a bird's foot.
> **Unified Modelling Language (UML)** used in non-database

The one we will study is the "crow's foot" notation.

1.2   Synthesis

Synthesis is the transformation of an ER model to a relational (or other) database or a combination of persistence technologies.

Some specific issues need to be dealt with the context of synthesising ER diagrams to relational databases.

2   Entities

Key terms:

Entity type: A group of objects with the same properties, wwhich are identified by the enterprise as having an independent existence.

Entity occurrence: A uniquely identifiable object of an entity type.

Often use "Entity" for both type and occurrence, although ambiguous, where meaning is obvious.

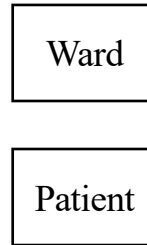Entities are represented by boxes in ER diagrams.

Ward

Patient

Figure 1: Entities as boxes

3 Attributes

Attribute type: a property of an entity type or relationship type.

Attribute domain: set of allowable values for attribute.

3.1   Simple / complex attributes

Simple attribute composed of single component with independent existence (e.g postcode)

Composite attribute composed of multiple components, each with independent existence.
(e.g. address)

3.2   Single / multi-valued attributes

3.3   Derived attributes

Derived attributes are those appearing as an attribute that are dynamically constructed from others:

For example a fullname constructed from firstname and lastname.

4   Relationships

Entities are linked together by relationships.

A relationship is an association between two entities that is important to the system of interest.

Relationship type A set of meaningful associations among entity types

Relationship occurrence A uniquely identifiable association that includes one occurrence from each participating entity type.

Often use "Relationship" for both type and occurrence, although ambiguous, where meaning is obvious.

4.1   Representation of a relationship

Relationships between entities are represented in an E-R diagram by a line connecting both entities.

It can sometimes be helpful to write the verb beside the line, but it's not required.

Also if the verb makes sense in one direction, an arrow is drawn from subject to object.
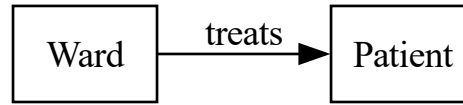
Figure 2: Relationship

4.2   Degree of Relationship

The degree of a relationship type is the number of participating entity types in a relationship [@connolly:2015:database].

Binary relationship has exactly 2 participating entities.

Complex relationship has degree greater than 2.

4.3 Cardinality

The cardinality of a relationship specifies how many related entity occurrences that an entity occurrence maps to, such as:

Abbreviation	Meaning
1:m	One-to-Many
m:1	Many-to-one
1:1	One-to-one
m:n	Many-to-many

Table 1: Cardinalities

Symbols for drawing cardinalities are shown in :

Figure 3: Representation of cardinality in Crow's Foot notation

If a NULL is allowed on one side of the relationship, then the minimum cardinality is zero on the other side. The relationship becomes zero-or-one-to-many, or zero-or-many-to-one etc.

4.4   Synthesising m:n relationships

Many-to-many relationships can't be directly implemented on a relational database. Instead, they have to be decomposed into two simpler relationships and a new entity has to be created:

1. Introduce a new linking entity.

2. Form two 1:m relationships.

4.5   Implementation

Roughly speaking:

- Entities become tables

- Attributes become columns

- 1-to-many / Many-to-1 Relationships are represented as foreign keys. The foreign key is set on the "many" table pointing to the "1" table.

4.6   Relationship participation

Participation determines "whether all or only some entity occurrences particiate in a relationship".

In this respect a relationship can be optional, mandatory or contingent.

4.6.1   Optional

An optional relationship is one where the minimum cardinality on both sides is zero.

Consider a car dealership:

- A customer may exist without a car. There may be customers on the books who have not purchased, but may purchase at a later date.

- A car may exist without a customer. There are cars that have not been purchased yet.

4.6.2   Mandatory

A mandatory relationship is one where the minimum cardinality on both sides is 1.

For example, a doctor must have patients and patients must have a doctor.

4.6.3   Contingent

A contingent relationship is one where:

1. On one side, the minimum cardinality is zero.

2. On the other side, the minimum cardinality is one.

Consider a trading business: A sales order must be associated with a customer, but at any point in time there may be no outstanding sales orders for some customers.

4.7 Exclusive relationship

An exclusive relationship is said to exist when the existence of one relationship precludes the existence of another.

For example, a patient may not be a patient in a ward and a patient in the outpatient department.

4.8   Recursive relationship

Relationship where same entity type participates more than once.