Systems Analysis and Design

4 Entity Relationship Diagrams (ERD)

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Entity Relationship Diagrams (also known as Logical Data Structure Diagrams) represent sets of objects and the relationships between them. We see what they look like and how to create them.

4.1 Entities

An entity is something on which we hold information. Examples of entities include Borrower, Loan, Copy and Title.

For Borrower we would record their id number, name, course, course end date and a loan history.

For Copy we would record its unique copy number (known as its accession number),, its title and its status, e.g. loanable or reference.

For Title we would record its title, author and the number of copies held in stock.

For Loan we would record borrowerId, copyId, dateDueForReturn and status - whether onLoan or returned.

An entity is shown as a named box with rounded corners.

Borrower

An entity is a set of similar objects.

Borrower = { tom, deepak, harry, ann, may, ... }

4.2 Relationships

A relationship is a connection between two entities. For example a Borrower may borrow up to six Copies at any one time, a Title might have zero, one or many Copies available for loan.
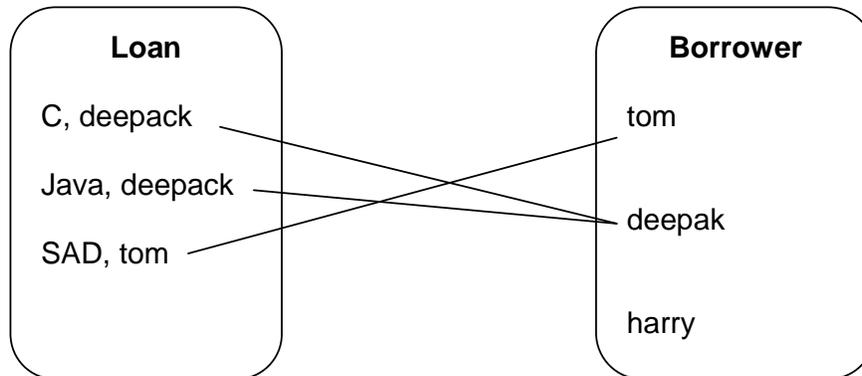
A relationship is usually one-to-many, e.g. one Borrower may have many Loans, one Title may have many Copies.

We describe relationships with a solid line drawn between entities.

The relationships may be annotated with the numbers involved in the relationship. To say that a Borrower may have zero, one or many Loans and a Loan is for just one Borrower we write:

```
        *              1
[ Loan ]───────────────[ Borrower ]
```
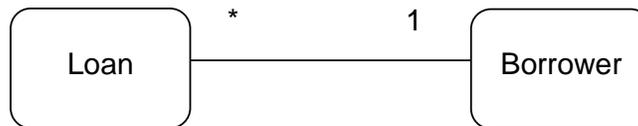
The * means zero, one or many.

```
┌───────────────┐              ┌───────────────┐
│     Loan      │              │   Borrower    │
│               │              │               │
│  C, deepack  ──┐         ┌──  tom           │
│               │ │        │    │               │
│  Java, deepack─┼┐        │    │               │
│               │ └────────┼──  deepak         │
│  SAD, tom    ──┘         │    │               │
│               │          │    │               │
│               │          │    harry          │
└───────────────┘              └───────────────┘
```

A Loan is for one Borrower. A Borrower may have zero, one or many Loans.

A Borrower may have many Loans during his or her lifetime as a member of the library.

The numbers involved in a relationship are known as its cardinality.

Relationships may also be annotated with a descriptive text and an arrow. The diagram shown below says A Loan *is for* one Borrower. And a Borrower *may have* zero, one or many Loans.
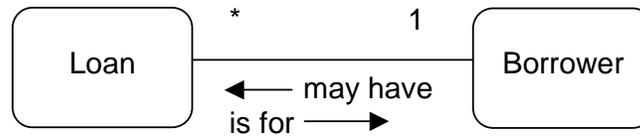
There are several styles for showing the number of entities involved in a relationship (e.g. crows feet) and the relationships themselves (e.g. diamonds). But we shall adopt the style shown here.

4.3 Database Design

There is a strong connection between ERD diagrams and database design. For example, each entity becomes a table in a database such as Access.

4.4 How to Construct an ERD

1. Identify entities e.g. Borrower, Title, Copy, Loan, Stock

2. Identify relationships e.g. a Stock contains many Titles. A Title has many Copies. Include additional entities to remove many-to-many relationships.

3. Draw the ERD. Place entities with the most relationships in the centre. Avoid crossed lines.

4. Check and redraw as many times as it takes to get it right.

4.5 Example ERDs

1. A title may have one or many authors. An author may have published many titles.
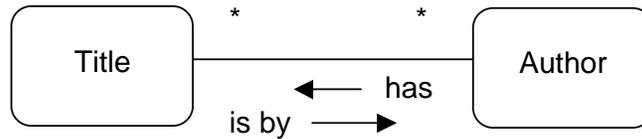
We have here a many-to-many relationship. So we introduce an additional entity, TitleAuthor, that links Title and Author, because we need to deal with one-to-many (or many-to-one) relationships.

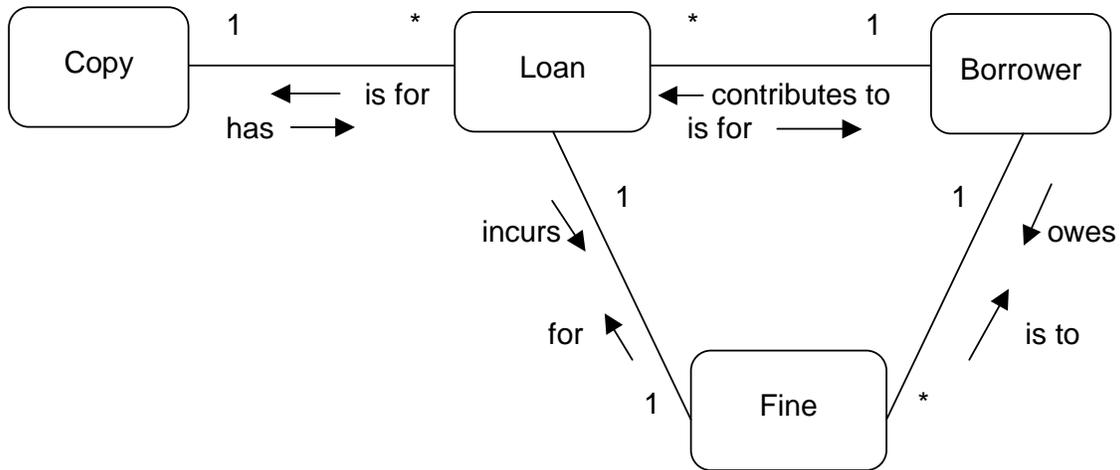A Title has zero, one or many TitleAuthor items. A TitleAuthor is for just one Title and one Author. An Author contributes to zero, one or many TitleAuthors.
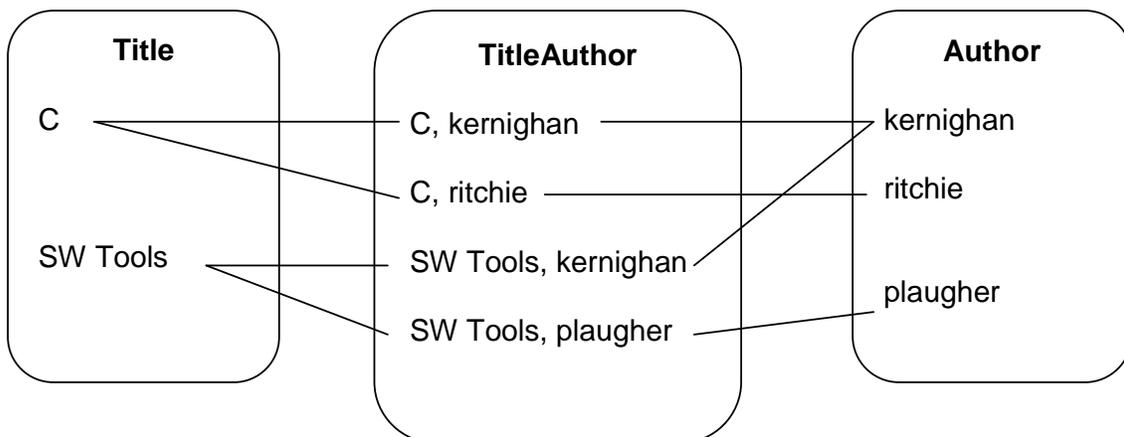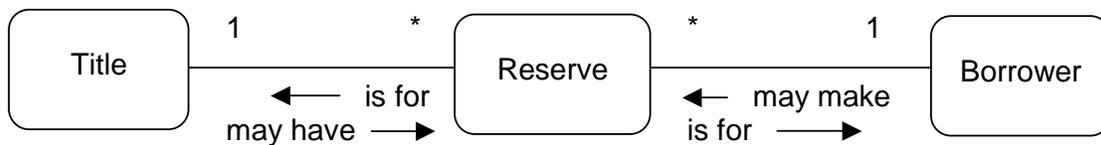

A Title may have several TitleAuthor pairs. A TitleAuthor is for just one Title and one Author. An Author may have contributed to one or several Titles.

2. In a library copies are loaned to borrowers. If a copy is not returned on time, a fine is charged.

```
Copy ──1────────*── Loan ──*──────────1── Borrower
         ◄─ is for      ◄─ contributes to
       has ──►          is for ──►

              incurs ┐1              1┐ owes
                     │                 │
               for ◄─┘1  Fine  *──┘ is to
```

A Loan is for one Borrower and one Copy. A Copy may have zero, one or many Loans in its lifetime.   A Borrower may have zero, one or many Loans in his or her lifetime. A Borrower may have zero, one or many fines for a Loan. A Loan has a Fine - which could be £0.00 - attached to it.

3. A Borrower may reserve a (copy of) a title if it is not available for loan.

```
Title ──1────────*── Reserve ──*──────────1── Borrower
          ◄─ is for              ◄─ may make
     may have ──►                is for ──►
```

A Borrower may make zero, one or many Reservations. A Reservation is for one Borrower and one Title. A Title may have many Reservations.

Exercise 4.1

1. Construct an ERD, and provide example sets, for each of the scenarios shown below.

      a. A student is enrolled on one or more courses. A course has zero, one or more students.

      b. Each course has one or more units. A unit may be used on zero, one or more courses.

      c. Each unit is delivered by zero, one or more lecturers. A lecturer delivers zero, one or more units.

      d. Each course is managed by a team leader. A team leader manages at least one course.

Bibliography

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