Database Design Methodology

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Objectives

- Understand Database Design Methodology, including:
  - Conceptual database design
  - Logical database design
  - Physical database design

"What color is your SQL Database?" by Scott Adams

Database Design Methodology

- A structured approach that uses procedures, techniques, tools, and documentation aids to support and facilitate the process of design.

- A design methodology consists of phases each containing a number of steps

Database Design Methodology

- Main phases
  - Gather requirements
  - Conceptual database design

    The process of constructing a model of the data used in an enterprise, independent of *all* physical considerations.
  - Logical database design

    Maps the conceptual data model on to a logical model (e.g. relational), but independent of a particular DBMS and other physical considerations.
  - Physical database design

    The process of producing a description of the implementation of the database (tailored to specific DBMS); it describes the base relations, file organizations, and indexes design, and any associated integrity constraints and security measures.

Overview Conceptual database design

- Step 1 Build conceptual data model
  - Step 1.1 Identify entity types
  - Step 1.2 Identify relationship types
  - Step 1.3 Identify and associate attributes with entity or relationship types
  - Step 1.4 Determine attribute domains
  - Step 1.5 Determine candidate, primary, and alternate key attributes

Overview Conceptual database design

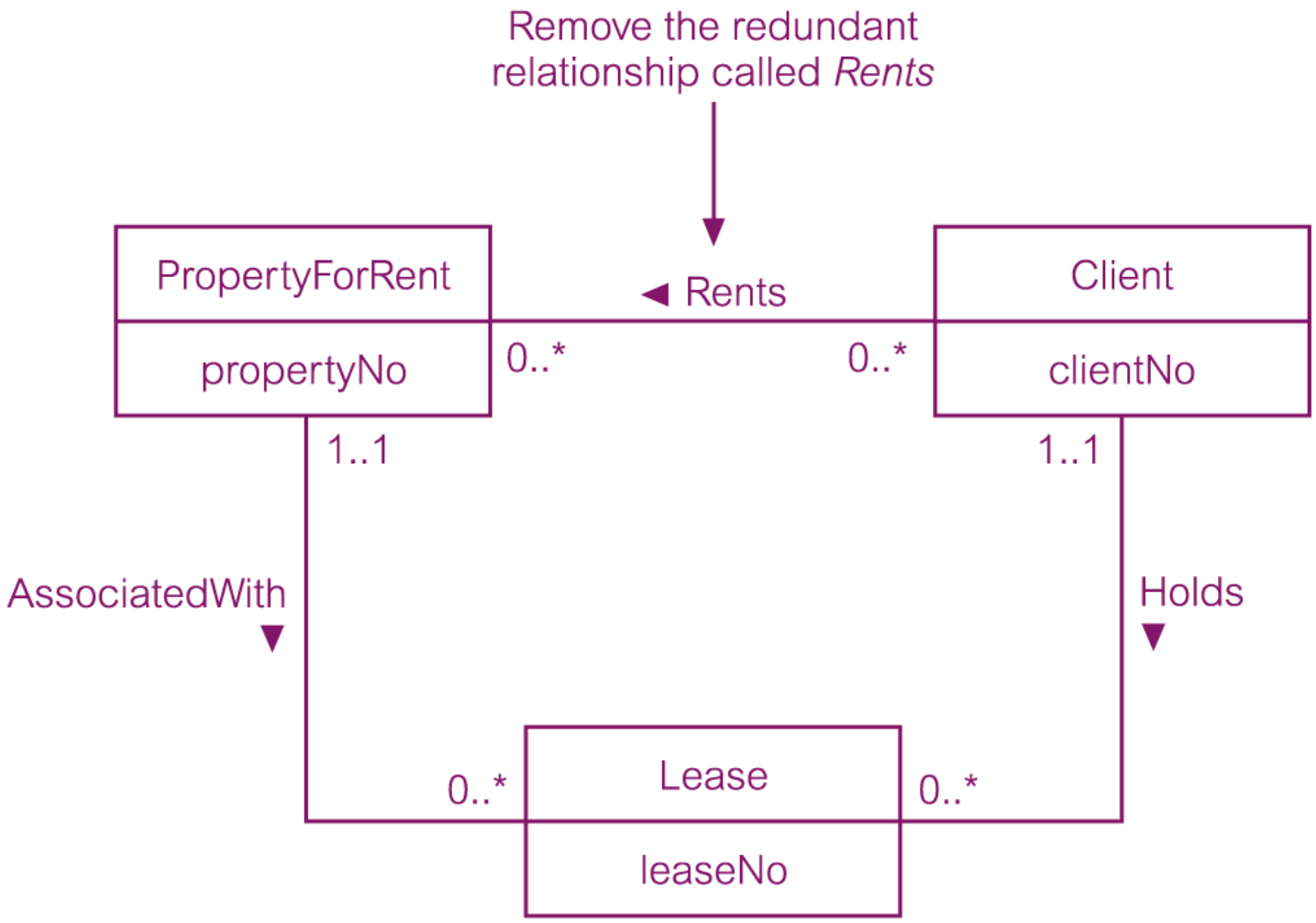
- Step 1 Build conceptual data model (continue)
  - Step 1.6 Consider use of enhanced modeling concepts (optional step)
  - Step 1.7 Check model for redundancy
  - Step 1.8 Validate conceptual model against user transactions
  - Step 1.9 Review conceptual data model with user

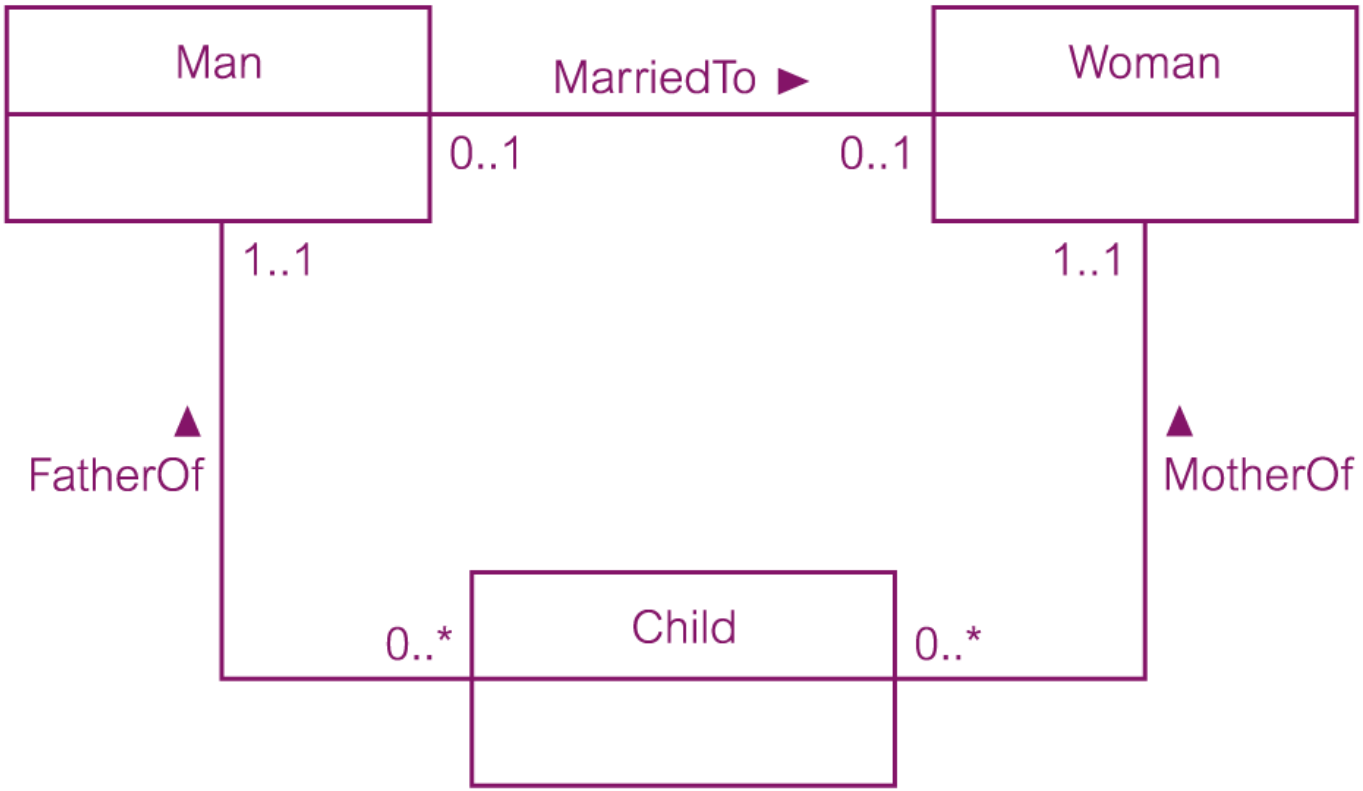
Step 1.5 Determine candidate, primary, alternate key attributes

- Guidelines for choosing candidate, primary, and alternate key attributes:
  - the candidate key with the minimal set of attributes;
  - the candidate key that is least likely to have its values changed;
  - the candidate key with fewest characters (for those with textual attribute(s));
  - the candidate key with smallest maximum value (for those with numerical attribute(s));
  - the candidate key that is easiest to use from the users' point of view.

Step 1.7 Check model for redundancy

- Re-examine one-to-one (1:1) relationships; Client, Renter
- Remove redundant relationships;
- Consider time dimension.


Remove the redundant relationship called *Rents*
PropertyForRent
propertyNo
Rents
0..*
0..*
Client
clientNo
1..1
1..1
AssociatedWith
Holds
0..*
Lease
leaseNo
0..*


Man
MarriedTo ►
Woman
0..1
0..1
1..1
1..1
▲
FatherOf
▲
MotherOf
0..*
Child
0..*

Logical database design

- Step 2 Build and validate logical data model
  - Step 2.1 Derive relations for logical data model
  - Step 2.2 Validate relations using normalization
  - Step 2.3 Validate relations against user transactions
  - Step 2.4 Check integrity constraints
  - Step 2.5 Review logical data model with user
  - Step 2.6 Merge logical data models into global model (optional step)
  - Step 2.7 Check for future growth

Step 2.4 Check integrity constraints

- To check integrity constraints are represented in the logical data model. This includes identifying:
  - Required data (value not allowed to be null)
  - Attribute domain constraints
  - Multiplicity (*:* relationships)
  - Entity integrity (primary key can not be null)
  - Referential integrity (foreign keys)
  - General constraints

Referential integrity

- Parent relation:

Staff (staffNo, fName, lName, position, sex, DOB, salary)

- Child relation:

PropertyForRent(propertyNo, street, city, postcode, type, rooms, rent, ownerNo, staffNo)

Case 1: insert tuple into child relation (PropertyForRent)

Case 2: Delete tuple from child relation(PropertyForRent)

Case 3: update foreign key of child tuple (PropertyForRent)

Case 4: Insert tuple into parent relation (Staff)

Case 5: Delete tuple from parent relation (Staff)

NO ACTION, CASCADE, SET NULL, SET DEFAULT

Case 6: Update primary key of parent tuple (Staff)

PropertyForRent (propertyNo, street, city, postcode, type, rooms, rent, ownerNo, staffNo)

Primary Key propertyNo

Foreign Key ownerNo **references** PrivateOwner(ownerNo) and BusinessOwner(ownerNo)

ON UPDATE CASCADE ON DELETE NO ACTION

Foreign Key staffNo **references** Staff(staffNo)

ON UPDATE CASCADE ON DELETE SET NULL

Physical database design for relational database

- Step 3 Translate logical data model for target DBMS
  - Step 3.1 Design base relations
  - Step 3.2 Design representation of derived data
  - Step 3.3 Design general constraints
- Step 4 Design file organizations and indexes
  - Step 4.1 Analyze transactions
  - Step 4.2 Choose file organization
  - Step 4.3 Choose indexes
  - Step 4.4 Estimate disk space requirements

Overview Database Design Methodology

- Step 5 Design user views
- Step 6 Design security mechanisms
- Step 7 Consider the introduction of controlled redundancy
- Step 8 Monitor and tune the operational system

Extra reading

- Database Systems: a practical approach to design, implementation, and management

  Chapter 18, 19, 20