Database Systems

Project: Design, development and implementation of a relational database

Case Study: Pawsome Pets

A company called Pawsome Pets runs multiple clinics. The company would like for their data to be stored in a database. The following description was obtained during the analysis phase:

“Each of the Pawsome Pets clinics has several staff members and a member of staff manages at most one clinic (not all staff manage clinics). Each clinic has a unique clinic number (clinicNo) and each member of staff has a unique staff number (staffNo). Additionally, the company would like to store each clinic’s name, address and telephone number, as well as the staff’s name, address, telephone number, DOB, position and salary.

When a pet owner contacts a clinic, the owner’s pet is registered with the clinic. An owner can own one or more pets, but a pet can only be registered at one clinic. Each owner has a unique owner number (ownerNo), a name, an address and a telephone number. Each pet has a unique pet number (petNo), name, DOB, animal species, breed and color.

When the pet comes to the clinic, it undergoes an examination by a member of the consulting staff. The database should store the following information for each examination: chief complaint (i.e., the main cause for the visit), description (i.e., what was done during the examination), date seen and actions taken (e.g., a treatment was prescribed, tests were ordered). A unique examination number (examNo) is assigned to each examination.

Develop a logical data model based on the following requirements: (11/21/24)

a. Derive relations from the conceptual model.

Relations Derived from Entity Types

Clinic

- Relation: Clinic(clinicNo, name, address, telephone)
- Primary Key: clinicNo
- address is a composite attribute and should include fields like street, city, and zip code.

Staff

- Relation: Staff(staffNo, name, address, telephone, dob, position, salary, clinicNo)
- Primary Key: staffNo
- Foreign Key: clinicNo references Clinic
- address is a composite attribute. There is a one-to-one relationship between Staff and Clinic for managers, and a one-to-many employment relationship.

Owner

- Relation: Owner(ownerNo, name, address, telephone)
- Primary Key: ownerNo
- address is a composite attribute.

Pet

- Relation: Pet(petNo, name, dob, species, breed, color, ownerNo, clinicNo)
- Primary Key: petNo
- Foreign Keys: ownerNo references Owner, clinicNo references Clinic

Examination

- Relation: Examination(examNo, chiefComplaint, description, date, actionsTaken, petNo, staffNo)
- Primary Key: examNo
- Foreign Keys: petNo references Pet, staffNo references Staff

Relations Derived from Relationships

Clinic-Staff (Management Relationship)

- Since there is a one-to-one relationship between a clinic and the staff who manages it, no additional table is needed. We can add a field managerNo to Clinic:
- Modified Relation: Clinic(clinicNo, name, address, telephone, managerNo)
- Foreign Key: managerNo references Staff(staffNo)

Owner-Pet (Ownership Relationship)

- This one-to-many relationship is captured by the foreign key ownerNo in the Pet relation.

Clinic-Pet (Registration Relationship)

- This one-to-many relationship is captured by the foreign key clinicNo in the Pet relation.

Pet-Examination (Examination Relationship)

- This one-to-many relationship is captured by the foreign key petNo in the Examination relation.

Staff-Examination (Performs Relationship)

- This one-to-many relationship is captured by the foreign key staffNo in the Examination relation.

b. Validate the logical model using normalization to 3NF.

Normalizations Analysis:

- **First Normal Form (1NF):** Ensure that each attribute contains only atomic (indivisible) values, and each record is unique.
- **Second Normal Form (2NF):** Ensure that each non-key attribute is fully functionally dependent on the primary key, meaning no partial dependency.
- **Third Normal Form (3NF):** Ensure that all non-key attributes are only dependent on the primary key and not on other non-key attributes, in other words, eliminate transitive dependencies.

1. Clinic Relation:

- 1NF: All attributes are atomic.
- 2NF: Each attribute is fully dependent on clinicNo
- 3NF: There are no transitive dependencies. The attribute managerNo is a foreign key referencing the Staff relation, and all other attributes depend directly on clinicNo.
- **Conclusion:** The Clinic relation is already in 3NF.

2. Staff Relation:

- 1NF: All attributes are atomic.
- 2NF: Each non-key attribute is fully dependent on staffNo.
- 3NF: There are no transitive dependencies. The attribute clinicNo is a foreign key referencing the Clinic relation, and all other attributes are directly dependent on staffNo.
- **Conclusion:** The Staff relation is already in 3NF.

3. Owner Relation:

- 1NF: All attributes are atomic.
- 2NF: Each attribute is fully dependent on ownerNo, which is the primary key.
- 3NF: There are no transitive dependencies.
- **Conclusion:** The Owner relation is already in 3NF.

c. Validate the logical model against 5 user transactions. (Note: These will be then implemented in 3c).

Transaction 1: Register a New Pet Owner

- Description: When a new pet owner registers at a clinic, the owner's information must be stored, including their unique ownerNo, name, address, and telephone.
- Validation: The Owner relation contains all the required attributes (ownerNo, name, address, telephone). Thus, the logical model supports this transaction as it allows inserting a new owner without violating referential integrity.

Transaction 2: Add a New Pet for an Existing Owner

- Description: When a pet is registered, it must be associated with an existing owner and clinic. The pet's information (petNo, name, dob, species, breed, color, ownerNo, clinicNo) must be stored.
- Validation: The Pet relation contains the attributes needed to store pet information and includes foreign keys (ownerNo and clinicNo) to reference the Owner and Clinic relations. The logical model supports this transaction, ensuring that a pet cannot be added unless the ownerNo and clinicNo exist, maintaining referential integrity.

Transaction 3: Record a New Examination

- Description: When a pet undergoes an examination, the details of the examination (examNo, chiefComplaint, description, date, actionsTaken, petNo, staffNo) must be recorded.
- Validation: The Examination relation includes all necessary attributes and foreign keys (petNo and staffNo). The logical model supports this transaction by allowing the recording of an examination while ensuring that a valid pet and staff member are associated with each examination, thereby maintaining data consistency.

Transaction 4: Update Staff Information

- Description: When a staff member's details change (e.g., their position or salary), these updates need to be made in the database.
- Validation: The Staff relation includes all staff attributes, such as position and salary, which can be updated as required. The logical model allows for modification of staff data directly without affecting referential integrity, as long as the staffNo remains unchanged.

Transaction 5: Retrieve Examination History for a Pet

- Description: A user may want to view the entire examination history for a given pet. This involves fetching all records related to a specific petNo.
- Validation: The Examination relation contains a foreign key (petNo) that links it to the Pet relation, allowing for the retrieval of all examinations for a particular pet. This relationship ensures that the model supports querying the examination history without any issues.

d. Define integrity constraints

I. Primary key constraints.

Table	Primary Key	Constraints
Owner	ownerNo	Unique, Not Null, Auto-Increment
Pet	petNo	Unique, Not Null, Auto-Increment
Staff	staffNo	Unique, Not Null, Auto-Increment
Clinic	clinicNo	Unique, Not Null, Auto-Increment
Examination	examNo	Unique, Not Null, Auto-Increment

II. Referential integrity/Foreign key constraints.

Clinic Table

Primary Key	Reference	References
managerNo	To identify the manager of the clinic.	Staff.staffNo

Staff Table

Primary Key	Reference	References
clinicNo	Which clinic a staff member is associated with	Clinic.clinicNo

Pet Table

Primary Key	Reference	References
ownerNo	Each pet has an existing owner	Owner.ownerNo
clinicNo	Each pet is registered at an existing clinic	Clinic.clinicNo

Examination Table

Primary Key	Reference	References
petNo	The examination is linked to an existing pet	Pet.petNo
staffNo	The examination is conducted by an existing staff member	Staff.staffNo

III. Alternate key constraints.

Owner Table:

Telephone is an alternate key since it is unique for each owner

Clinic Table:

Telephone is also unique since it is unique for each clinic

IV. Required data.

Owner Table: ownerNo, Name, Address, Telephone.

Pet Table: petNo, Name, DOB, Species, ownerNo.

Staff Table: staffNo, Name, DOB, Position, clinicNo.

Clinic Table: clinicNo, Name, Address, Telephone.

Examination Table: examNo, chiefComplaint, Date, petNo, staffNo.

V. Attribute domain constraints.

Clinic Table

Attribute	Data Type	Domain Constraints
clinicNo	Integer	Positive, Auto-increment
Name	String	Max length: 100
Address	String	Composite: Street (Max 100), City (Max 50), ZIP (5-10 digits)
Telephone	String	Exactly 10 digits, Numeric

Staff Table

Attribute	Data Type	Domain Constraints
staffNo	Integer	Positive, Auto-increment
Name	String	Max length: 100
Address	String	Composite: Street (Max 100), City (Max 50), ZIP (5-10 digits)

Telephone	String	Exactly 10 digits, Numeric
DOB	Date	Format: YYYY-MM-DD
Position	String	Enum
Salary	Decimal	Positive, Min value: 0.00
clinicNo	Integer	Must match clinicNo in Clinic

Owner Table

Attribute	Data Type	Domain Constraints
ownerNo	Integer	Positive, Auto-increment
Name	String	Max length: 100
Address	String	Composite: Street (Max 100), City (Max 50), ZIP (5-10 digits)
Telephone	String	Exactly 10 digits, Numeric

Pet Table

Attribute	Data Type	Domain Constraints
petNo	Integer	Positive, Auto-increment
Name	String	Max length: 100
DOB	Date	Format: YYYY-MM-DD
Species	String	Enum: ('Dog', 'Cat', 'Bird')
Breed	String	Max length: 50
Color	String	Max length: 50
ownerNo	Integer	Must match ownerNo in Owner (FK)
clinicNo	Integer	Must match clinicNo in Clinic (FK)

Examination Table

Attribute	Data Type	Domain Constraints

examNo	Integer	Positive, Auto-increment
chiefComplaint	String	Max length: 250
Description	String	Max length: 500
Date	Date	Format: YYYY-MM-DD
actionsTaken	String	Max length: 250
petNo	Integer	Must match petNo in Pet (FK)
staffNo	Integer	Must match staffNo in Staff (FK)

VI. General constraints.

Clinic Management Constraint:

- Each clinic can have at most one manager.

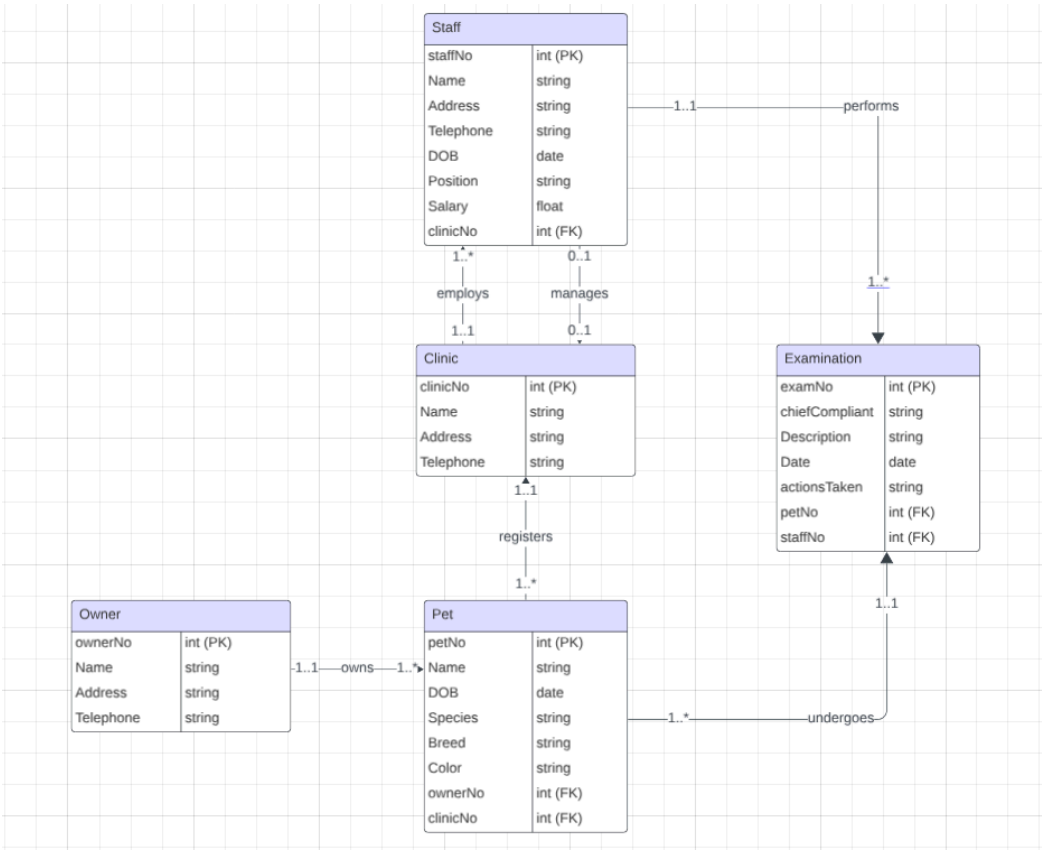
Owner-Pet Relationship:

- Every pet must have an owner.
- Every owner must have at least one pet.

Examination-Pet and Examination-Staff Relationships:

- Every examination must involve one pet.
- Every examination must be performed by one staff member.

VII. Generate the E-R diagram for the logical level


Staff
staffNo
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Name
string
Address
string
Telephone
string
DOB
date
Position
string
Salary
float
clinicNo
int (FK)
1..1
performs
1..*
1..*
employs
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manages
1..1
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Clinic
clinicNo
int (PK)
Name
string
Address
string
Telephone
string
Examination
examNo
int (PK)
chiefCompliant
string
Description
string
Date
date
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string
petNo
int (FK)
staffNo
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1..1
registers
1..*
1..1
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Name
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Address
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Telephone
string
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owns
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Pet
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Name
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DOB
date
Species
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Breed
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Color
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clinicNo
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1..*
undergoes