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Conceptual Design For the Database of a Hospital Management System

Employee

- In a Hospital there are multiple Employees that work there, each employee has their own credentials, Id's and other identifications, an Id is unique for each employee. Each employee has specific work time schedule and work days. Each employee also has a certain status that determines their position in the hospital, thus one Employee can only have 1 status but Multiple employees can have the same status. There are 3 main branches that can emanate from the employee category, these are:

    - Doctors
    - Manager
    - Other Staff

- The branches stated above have no relation to one another meaning a doctor cannot be a manger or Other staff member, the other way around holds true too

- Incorporating the above statement into our conceptual Design, we can extract the following:

    - **Entities:** from the above requirement we can extract one main Entity which is the **Employee** entity, this entity is a super class that holds 3 sub classes under it, these subclasses are Doctors, Manager and Other Staff, the relation between this sub classes are that they are disjoint This Entity has several attributes of its own which are stated below

    - **Attributes:** We can have the following attributes for the entity employee, this are:
        - **Id:** This attribute is a simple attribute, it holds the value of the id of any employee, this is the primary key of the entity

- **Phone No:** This is a simple attribute, it holds the phone number of the employee's, this is a candidate key for the entity.
- **Birthdate:** This is a composite attribute, it is composed of the following attributes: **date**, **month**, **year**; these attributes are simple attributes. this attribute holds the birth date of the employee
- **Name:** this is a composite attribute, it is composed of the following attributes: **First name**, **Middle name**, **Last Name**; these attributes are simple attributes. this attribute holds the name of the employee
- **Work time:** this is a composed attribute, it is composed of the following attributes: **start time**, **end time**, **work days**; the first two attributes are simple attributes and the third attribute is a multivalued attribute. the work time attribute holds the value holds the work time of the employees
- **Address:** this is a composite attribute, it is composed of the following attributes: **Country Name**, **City Name**, **Street Name**; these attributes are simple attributes. Address attribute holds the address of the employee
- **Sex:** this is a simple attribute, it holds the gender type of the employee

ATTRIBUTES	TYPE	COMPOSED OF
ID	Simple Attribute	-
NAME	Composite Attribute	First Name, Last Name, Middle Name
PHONE No	Simple Attribute	-
BIRTH DATE	Composite Attribute	Date, Month, Year
WORK TIME	Composite Attribute	Start Time, End Time, Work Days
ADDRESS	Composite Attribute	Country, City, Street Name
SEX	Simple Attribute	-

- **Relations:** we can extract a relation between Employees and Status, since each employee has a status and each status is occupied by an employee, we can say that both employee and status have a complete relation with each other. When we come to the cardinality Ratio, the requirement states that each a single has only one status, but multiple employees can have the same status, thus the cardinality ratio is N:1

RELATION NAME	RELATION ATTRIBUTES	PARTICIPATION CONSTRAINT	CARDINALITY RATIO
HAS (BETWEEN EMPLOYEE AND STATUS)	-	From employee: Full From Status: Full	N:1(Employee: Status)

Patient

- Electronic health records should contain all necessary patient information and be easily accessible and constantly updated with minimum effort.
  There are three Target Audiences of Hospital Management Systems.
    - Hospital administration
    - Doctors
    - Patients.

- Every hospital treats a number of patients. Each patient has a name, ID, sex, age, birth date, address and phone number to register into the hospital system since a proper patient registration is the foundation upon which the rest of the patient-interaction system login is build. A patient may have an appointment with doctors with a specific date and time. Then when a patient visits his/her doctor, diagnosis record will be taken by doctors which states the case and prescription. So the doctor suggests if a patient needs to use facilities such as laboratory, rooms and etc.
  The hospital management system database (DB) will store each patient name, ID, sex, age, birth date, address and phone number.

- The DB will keep track of Appointments that the patient has with start time, end time and date.
  It is also required to keep track of diagnosis record of patients which states the case and prescription.
  It is required to keep track of usage of facility such as room, nurse and laboratory by each patient.

o **Entities:** One of the entities for hospital management system is patient the one that receive or registered to receive medical treatment.

o **Attributes:** The entity patient has attributes that are properties used to describe patients. Patient's attributes are name, ID, sex, age, birth date, address and phone number.

- **Name:** holds the name of the patient and it is composite attribute composed of First Name, Middle Name and Last Name.

- **ID:** holds the value of the id of the patient and it is simple attribute.
  -It is the primary key of the entity patient.

- **Sex:** tells us either the patient is male or female so it is simple attribute.

- **Birth date:** holds patient date of birth and it is composite attribute composed of Data, Month and Year.

- **Address:** holds the address of patient and it is composite attribute composed of Street Name, City and Country.

- **Phone Number:** holds phone no of patient and it is simple attribute since the patient may have 2 or more phone numbers.

ATTRIBUTES	ATTRIBUTES TYPE	COMPOSED OF
NAME	Composite	First name (F. Name), Middle name (M. Name), Last name (L. Name)
ID	Simple	-
SEX	Simple	-
BIRTHDATE	Composite	Date (DD), Month (MM), Year (YY)
ADDRESS	Composite	Street Name, City, Country
PHONE NO	Simple	-

o **Relations:** By the requirements, three relationship types are identified and all are binary relationships (degree 2). The following are relationship with their participating entity types:

- **APPOINTMENT (between PATIENT, DOCTOR):** Appointment is a relationship between patients and doctors that allows for scheduling and managing appointments. The relation has attributes such as start time and date. The system notifies patients about their appointments. This function may be provided by a separate web, mobile application or text message linked to the hospital management system. Some patients might not have prior appointments and also all Doctors might not have appointments thus they have partial participation constraint. Regarding the cardinality ratio each patient has appointment with one doctor but a doctor can have an appointment with multiple patients, thus the cardinality ratio is N:1.

- **DIAGNOSIS RECORD (between PATIENT, DOCTOR):** Diagnosis Record is a relationship between patients and doctors that keeps track of diagnosis record of patients. The relation has attributes such as prescription and case. All patient will have a diagnosis report and when we come to the doctor side all doctors may not give diagnosis report thus the participation constraint from the patient side is full and the participation constraint from the doctor side is partial. Regarding the cardinality ratio each patient has diagnosis report from one doctor. Thus, the cardinality ratio is 1:1.

- **USAGE (between PATIENT, FACILITY):** Usage is a relationship between patients and facility that keeps track of usage of hospital facilities such as rooms, nurse and laboratory. Each patient may or may not use facilities so both patient and facility have a partial relation with each other which is represented by a single line. Regarding the cardinality ratio, since a single patient can access multiple facilities and also multiple patients can have access to a single facility at the same time. Thus, the cardinality ratio is N: M.

RELATIONSHIP	ATTRIBUTES	ATTRIBUTE TYPE	CARDINAL RATIO	PARTICIPATION CONSTRAINT
APPOINTMENT	Start time, Date	Complex	N:1	From Patient: Partial From Doctor: Partial
DIAGNOSIS RECORD	Case, Prescription	Simple	1:1	From Patient: Full From Doctor: Partial
USAGE	-	-	N:M	From Patient: Partial From Facilities: Partial

Doctors

- One of the employee groups in a hospital management system are doctors. Doctors as other employees have their own ID, phone number and other attributes that differentiate them from other employees. Different entities can be derived from doctors and this may include Specialization. A doctor specializes in a certain specific field. Different specializations are uniquely identified by their attributes and are related to different doctors.

- Doctor ⟶ Specialized in ⟶ Specializations

- Doctors also have some relations with some other entities in the hospital management system. To mention some of them, doctors have relations with patients. A patient may book an appointment with a specific doctor in the hospital. And this appointment has its own attributes that identifies it.
- Patient ⟶ appointment ⟶ Doctor
- Other relations with patients can be a diagnosis record of the patient. A doctor fills the diagnosis record of every patient that is in his care. This diagnosis record relation may contain different attributes.

- Doctor ⟶ Diagnosis record ⟶ Patient

-   As mentioned above, one of the entities that can be derived from the entity doctors is specialization. This entity is the subclass of the doctor's subclass which is also the subclass of the employee super class.

    o   **Attributes:** This entity(specialization) has different attributes that belongs to it. These include specialization ID (S_ID) and specialization name (S_Name).

        ▪   **S_ID**: This attribute is a simple attribute and is the id given to each specialization that is found in the hospital. This is the primary key for the specialization entity.

        ▪   **S_Name**: This is also a simple attribute that holds the name for the specialization.

ATTRIBUTES	TYPE	COMPOSED OF
S_ID	Simple attribute	-
S_NAME	Simple attribute	-

    o   **Relations**: As slightly mentioned above, different relations can be derived from doctor and other entities that are found in our database system. These include a doctor specialized in some specializations, a doctor may hold the diagnosis record of patients, and a patient may book an appointment to some specific doctor. The cardinality ratio between the above relation are as follows: each doctor can specialize in multiple areas and there might be many doctors that specialize on the same field. Thus, the cardinality ratio is N:M. Coming to the participation constraint, All doctors will specialize in at least 1 field, but there might be some specialization areas that are vacant, meaning there are no doctors that specialize in that area. Thus, the participation constraint in for this relation from the perspective of the doctor is full and for the specialization it is partial.

RELATION NAME	RELATION ATTRIBUTES	PARTICIPATION CONSTRAINT	CARDINALITY RATIO
SPECIALIZES_IN	-	From Doctor: Full From Specialization: partial	N:M

Manager

ENTITY: MANAGER

Hospitals are organizations that give health care service for patients and while giving service to patients, hospitals are also expected to generate income and profit. To generate this income and profit hospitals need people to handle their administrative works like budgeting, salary payment, human resources and supply maintenance. And people who can handle these jobs are the managers of the hospital so managers are one of the intricate parts of the hospital organization.

Managers in the healthcare facility have a legal and moral obligation to create and foster a quality and safe patient care system and for that they are responsible for the type of employees the hospital have on moral and technical basis to give patients the appropriate service.

Managerial positions in health care systems or hospitals are different and divided into branches. So, based on their academic and managerial skill managers can attain different levels of management. One can be chief managers of the hospital some can be managers for the physicians some can be managers for other employees and some can be managers for different facilities in the hospital.

When designing this database managers are one of the disjoint sub-class of the employee entity. The manager sub-class manages the status of employee entity. The status an employee is therefore managed by the manager where the manager will have access to the status of every employee that works under him of in the manager's facility. The general or chief manager of the employee will have access to all the employee including all the sub-managers that are working under him.

Every Manager by itself is also an employee to the hospital.

ENTITY: STATUS

Employees in any organization are divided based on their ability, specialization, number of years worked in the organization. So, hospitals as one kind of organization will have status for its employees and status of the employee can be the number of years worked for the hospital or experience level, specialization or any other form of skill and based on these status the employee's salaries will vary. Again, based on the job type of the employee which is another status its clearance to different facilities will vary and based on other parameters the employee's status level will also vary.

The status of an employee in the database is an entity that has five attributes in it. The first attribute is status ID, the second attribute is the status level, the third attribute is the clearance level, the fourth attribute is the salary attribute and the fifth and last attribute is the salary status.

The first attribute for the status entity is the status ID that will serve as the primary key for the status entity.

The second attribute for the status entity is status level. The status level of an employee signifies the status of the employee in the hospital and the status level of an employee is given for the first time when an employee is hired and the status level of a hired employee can change when the employee gets promoted or demoted.

The third attribute for the status entity is clearance level. The clearance level of an employee shows the facilities an employee is allowed to enter or it tells the amount of access an employee has to the different facilities of the hospital. As the clearance level of the employee increases more access will be given to the employee and as the clearance level decrease the less access that employee will have to the facilities of the hospital.

The fourth attribute for the status entity is salary amount. The salary attribute of the employee tells the amount of salary and employee is paid in the hospital.

The fifth and last attribute for the status entity is the salary status. The salary status of the employee shows salary of an employee is paid or not and if not paid it shows the number of months the employee hasn't been paid.

Attribute	Type	Composed Of
Status ID	Simple Attribute	-
Status Level	Simple Attribute	-
Clearance Level	Simple Attribute	-
Salary	Simple Attribute	-
Salary Status	Composite	Paid, Unpaid, Number of months

Relations

Manager entity is related to the status entity. The manager manages the status of employees. A single manager has access to employees working under his facility or each manager manages the employee that works for him.

Status of the employee can be related to the manager with its status id. With the status id the manager for that exact employee can be known and the manager gets access to control the status to the employee like promoting the employee and increasing its status level or demoting the employee so that the status level of the employee will decrease. The manager can also change the clearance level of the employees that are working under him so that the employee can get access to more or a smaller number of facilities in the hospital.

Participation constraint

Since all managers can access the status of employees and each and every status can be manipulated by a manager the participation of both entities is full.

Cardinality ratio

Since multiple managers can access and manipulate single employee's status and also a single manager can access and manipulate multiple employees' status the cardinality ratio becomes N to M.

Relation	Relation Attribute	Participation Constraint	Cardinality Ratio
Manages (Between manager and status)	-	-From manager: Full -From status: Full	N:M (manager to status)

Other Staff Employees

- There are different Employees other than Doctors and Managers, these employees work in different facilities of the hospital. All these employees work in different facilities found in the hospital. Since they are employees, they will be given ids and status to identify them and their value. Different staff employees can work in the same facility while a single staff employee works in one facility.
- Incorporating the above statement into our conceptual Design, we can extract the following:

  - **Entities:** The entity that we can extract from this is the **Other Staff employee**. This is a subclass of the employee superclass. This entity has the following relation.

  - **Relation:** We can extract that there is a relation between other staff employee and facility. Since all members in this group work in a facility and all facility is equipped with a worker then they both have full participation in the relation. Regarding the cardinality ratio, since different members can work In the same facility but a single employee can work in only a single facility then the cardinality ratio becomes N:1.

RELATION NAME	RELATION ATTRIBUTES	PARTICIPATION CONSTRAINT	CARDINALITY RATIO
WORKS ON (BETWEEN OTHER STAFF AND FACILITY)	-	From other staff: Full From facility: Full	N:1(Employee: Status)

FACILITIES

- Health facilities are places where different kinds of services are provided to patients. In a hospital different kinds of health facilities are included such us (Clinical Labs, Imaging and Radiology centers, Nursing homes, Pharmacies, Outpatient clinics, Long term care facilities, Hospice homes, Blood banks, Rooms, Inventory, etc..)
- A hospital management system will include the management of multiple kinds of services that are available in the health facilities.
- In our Hospital Database Management System facility is one of our main Entities.
- The purpose of including facilities as one entity is in order to manage different kinds of service data that has to be stored in the database.

- Our Hospital Database Management System includes the management of the general and more essential types of hospital facilities. These are:
    o Medical care units (Rooms)
    o Clinical lab and Radiology centers
    o Pharmacy (Drug Store)
    o Inventory

    o **Entities:** from the above requirement we extracted one of our main Entity which is **FACILITY** entity, we used this entity as a superclass that holds 5 subclasses under it in order to include different kinds of facilities stated in the requirement. These subclasses are **Medical care units (Rooms), Clinical labs and Radiology centers (Labs), Pharmacy, and Inventory**. The relation between the subclasses are a disjoint relation. The superclass entity has its own attributes.

    o **Attributes:** For the facility entity we can have the following attributes, which are:

        ▪ **Facility_id**: this attribute is a simple attribute, it will hold the value of the id of the facility, this is the primary key of the entity.
        ▪ **Facility_name:** this is a simple attribute, it will hold the name of the facility. It is a simple attribute because a facility can only one name.
        ▪ **Facility_location:** this attribute is a multivalued attribute, this attribute holds a location of the facilities. It is a multivalued because one facility can be located in different locations.

ATTRIBUTES	TYPE	COMPOSED OF
FACILITY_ID	Simple attribute	-
FACILITY_NAME	Simple attribute	-
FACILITY_LOCATION	Multivalued attribute	Different values

For the subclasses we can have the following attributes, which are:

Medical care units (Rooms)
- **Room type:** this is a simple attribute; this attribute holds the types of each individual units or rooms.
- **Room_no:** this is a simple attribute; this attribute will hold the number of the room or unit.
- **Room_status:** this is a simple attribute; this attribute will hold the availability of room or unit.

ATTRIBUTES	TYPE	COMPOSED OF
ROOM_TYPE	Simple attribute	-
ROOM_NO	Simple attribute	-
ROOM_STATUS	Simple attribute	-

Clinical labs and Radiology centers (Labs)
- **Lab_type:** this is a simple attribute, it will hold a description data about the lab type.
- **Lab_service:** this is a multivalued attribute. This attribute is multivalued because one lab can provide different kinds of services.
- **Service_fee:** this is also a multivalued attribute as it depend on the lab services given. It will hold the service fee of each labs.

ATTRIBUTES	TYPE	COMPOSED OF
LAB_TYPE	Simple attribute	-
LAB_SERVICE	Multivalued attribute	Different values
SERVICE_FEE	Multivalued attribute	Different values

Pharmacy (Drug stores)
- **Drug_name:** it is a simple attribute. This attribute will hold a name of the drug in the store.
- **Drug_id:** it is a simple attribute. This attribute will hold a id of the drug in the store.
- **Drug_status:** it is a simple attribute. This attribute will hold a data about the availability of the drug in the store.
- **Drug_price:** this is a simple attribute. It will hold the price of a particular drug.

ATTRIBUTES	TYPE	COMPOSED OF
DRUG_NAME	Simple attribute	-
DRUG_ID	Simple attribute	-
DRUG_PRICE	Simple attribute	
DRUG_STATUS	Simple attribute	-

Inventory

- **Inventory_kind:** this is a simple attribute, this attribute hold the types of each inventory items.
- **Inventory_id:** this attribute is a simple attribute, this attribute is unique for this subclass it will hold the id the inventory item which is different from the facility id inherited from the superclass.
- **Inventory_status:** this is a simple attribute, this attribute will hold the amount inventory left in the hospital.

ATTRIBUTES	TYPE	COMPOSED OF
INVENTORY_KIND	Simple attribute	-
INVENTORY_ID	Simple attribute	-
INVENTORY_STATUS	Simple attribute	-

o **Relations:** from the above Facility entity we can extract different kinds of relations also from the subclasses.

For the Facility Entity we can create a relation between **Facility** and **Other Staff workers** which was described in the previous pages,

For the Subclasses the Relations are:

- The Relation between **Medical Care Unites (Rooms)** and **Patients** can be extracted from the requirement as an assignment relation when an inpatient is assigned to a particular room to get long or short term medical care. This relation is not a complete relation since every patients are not assigned to a room and at the same time some rooms can be unoccupied]. When we see the cardinality ratio multiple patients can be assigned to the same room but only a single room can be assigned to a patient. Thus the cardinality is N:1.

Attributes: this relation will contain its own attributes which are,

- **Entry_date:** this a simple attribute. It will hold the day that the patient is assigned to the room.
- **Discharge_date:** this a simple attribute. It will hold the day that the patient is will be discharged from to the room.

RELATION NAME	RELATION ATTRIBUTE	PARTICIPATION CONSTRAINT	CARDINALITY RATIO
ASSIGNED IN (BETWEEN ROOMS AND PATIENTS)	Entry_date Discharge_date	From Patients: partial From Rooms: partial	N:1(Patients:Room)

- The relation between **Clinical labs and Radiology centers (Labs)** and **Patients** can be extracted from the requirement as a usage relation when an inpatient or outpatient is uses a particular laboratory service. This relation is not a complete relation since every patients does not use all the lab services. When we see the cardinality ratio multiple patients can use same lab service also multiple lab services can be used by a single patient. Thus the cardinality is N:M.

Attributes: this relation will contain its own attributes which are,

- **Usage_date:** this a simple attribute. It will hold the day that the patient used a lab service.
- **Result:** this a simple attribute. It will hold the day that the patient's lab result.

RELATION NAME	RELATION ATTRIBUTE	PARTICIPATION CONSTRAINT	CARDINALITY RATIO
USES (BETWEEN LAB AND PATIENTS)	Usage_date Result	From Patients: partial From Labs: partial	N:M(Patients:Lab)

- The relation between **Pharmacy (Drug stores)** and **Patients** can be extracted from the requirement as purchase relation when an inpatient or outpatient buys a particular medicine. This relation is not a complete relation since every patients does not buy a medicine. When we see the cardinality ratio multiple patients can buy same medicine also multiple medicines can be sold to one patient. Thus the cardinality is N:M.

  Attributes: this relation will contain its own attributes which are,

    - **Date:** this a simple attribute. It will hold the day that the patient purchases a drug.
    - **Prescription detail:** this a simple attribute. It will hold the day that the patient detail prescription.

RELATION NAME	RELATION ATTRIBUTE	PARTICIPATION CONSTRAINT	CARDINALITY RATIO
PURCHASES (BETWEEN PHARMACY AND PATIENTS)	Date Prescription detail	From Patients: partial From Pharmacy: partial	N:M(Patients:Pharmacy)

The Next page shows the EER of our overall Design: