# **DATABASE SYSTEMS**

## **ENTITY RELATIONSHIP DIAGRAMS**

1. A hospital has large number of registered physicians. Attributes of physicians include physician-ID and specialty. Patients are admitted to the hospital by physicians. Attributes of patient include patient-ID and patient-name. Any patient who is admitted must have exactly one admitting physician. A physician may optionally admit any number of patients. Once admitted a given patient may be treated by at least one physician. A particular physician may treat any number of patients. Whenever a patient is treated, the hospital wishes to record the details of treatment (Treatment-Detail). Components of Treatment-Detail include: Date, Time and Results. **(GRPA1)**
2. A real estate firm lists property for sale. The company has a number of sales offices. Attributes of sales office include office number and location. Each office is assigned one or more employees. Attributes of employee include employee ID and employee name. An employee must be assigned to only one sales office. For each sales office there is always one employee assigned to manage that office and one can only manage the sales office to which (s)he is assigned. The firm lists property for sale. Attributes for property include property ID and location. Location components include address and town. Each unit of property must be listed with one (and only one) of the sales offices. A sales office may have any number of properties listed or may have no properties listed. Each unit of property has one or more owners. Attributes of owners are owner ID and owner name. An owner may own one or more units of property. An attribute of the relationship between property and owner is percent-owned. **(GRPB-1)**
3. A company has a number of employees. The attributes of employee include: Employee-ID, Name, Address, and Birth-Date. The company also has several projects whose attributes include Project-ID, Project-Name, and Start-Date. Each employee may be assigned to one or more projects, or may not be assigned a project. A project must have at least one employee assigned or may have any number of employees assigned. An employee’s billing rate may vary by project and the company wishes to record the applicable billing rate (Billing-Rate) for each employee when assigned to a particular project**.(GRPA-2)**
4. Our company arranges rentals of properties owned by both private and business owners. We assign every property owner a unique owner number for identification, we record its address (consisting of a street, street number, town or city, and province), the owner’s name (consisting of first, middle, and last name for a person or name of a business), and the owners email addresses and the owner phone numbers. For a business owner, we record the type (description) of its business. Each property is identified by a unique property number, we record its address and its type. Each property may be placed in several advertisements. Each such advertisement may be displayed in many newspapers on several dates. The newspapers are identified by unique names. The term renter refers to a private person or a business who signed a rental agreement for a property. Each such rental agreement is identified in our database by a unique rental number. We record the date of the singing of the rental agreement, the starting and ending date of the rental agreement. A renter can rent many properties. A renter, prior to accepting the rental agreement may view the property repeatedly and we record the date of viewing. For each renter, we record its address, its name, its email address and phone numbers. Each renter has a unique renter number in our database. Our agency is organized into branches and every staff member is allocated to exactly one branch. Each branch has one manager who is a member of the staff. In our database, we identify the staff by a unique staff number. For each staff member we record address, name, email address, phone numbers, sex, position, and salary. Each property is in care of one of our branches. Each renter refers to the branch that is in care of the property it rents. Each property is overseen by a unique staff member. Each branch has an address, phone number, and a unique branch number. **(GRPB-2)**
5. An NGO depends on a number of different types of persons for its successful running. The organization is interested in all of these attributes for all those persons: SSN, Name, address and phone. There are three kinds of persons who are of great interest: employees, volunteers and donors. In addition to the attributes of person, an employee has date hired and a volunteer has skill. A donor is a person who donates one or more items to the organization. An item specified by a name may have no donors or one or more donors. When an item is donated, the organization records its price so that at the end of the year it can identify the top 10 donors. There are persons other than employees, volunteers and donors that are of interest to the organization such that a person need not belong to any of these groups. On the other hand, a person may belong to two or more of these groups e.g. employee and donor.**(GRPA-3)**
6. A bank has three types of accounts namely checking savings and loans. Each of these has the attributes account number, date opened and balance. In addition to theses attributes, checking has service charge, savings has interest rate and loans has interest rate and payment. At the end of the month the bank computes the balance of each account and mails the statement to the customer holding that account. The balance computation depends on the type of account. Assume that each bank account must be a member of these subtypes. **(GRPB-3)**
7. A company is developing a registration system to maintain all information about all vehicles registered in a certain country. For each vehicle registered, the system has to store name, address, phone number of the owner, the start date and end date of registration, plate information (issuer, year, type and number), sticker (year, type, number) and registration fee. The following additional information is maintained about the vehicles themselves: number, year, model, make, weight, color and mileage. The system issues registration notices to owners of vehicles whose registrations are due to expire after two months and when the owner renews registration the system updates the registration information of the vehicle.(**GRPA-4**)
8. ABC University is a large institution with several campuses. Each campus has a different name, address, distance to the city center and the only bus running to the campus. The University consists of a number of faculties, such as the Art Faculty, the Science Faculty, and so on. Each faculty has a name, dean and building. A faculty may be divided into a number of schools, for example, the Science Faculty has a School of Physics and a School of Chemistry. Each school belongs to one faculty only and is located on just one campus, but one campus maybe the location of many schools. Every school has name and an building assigned to. Each school offers different programmes and each programme can be offered by only one school. Each programme has a unique code, title, level and duration. Each programme comprises several courses, different programmes have different courses. Each course has a unique code and course title. Some courses may have one or more prerequisite courses and one course can be the prerequisite course of some other courses. Each of the students is enrolled in a single programme of study which involves a fixed core of courses specific to that programme as well as a number of electives taken from other programmes. Students work on courses and are awarded a grade in any course if he/she passes the course. Otherwise the student has to re-take the failed course. The system needs to record the year and term in which the course was taken and the grade awarded to the student. Every student has a unique ID. The system also keeps the student name, birthday and the year he/she enrolled in the course. The school employs lecturers to teach the students. A lecturer is allowed to work for one school only. Each lecturer is assigned an ID which is unique across the whole university. The system keeps the lecturer’s name, title and the office room. A supervisor maybe in charge of several lecturers, but a lecturer, however reports to only one supervisor. A lecturer can teach many different courses. A course may also have been taught by many different lecturers. **(GRPB-4)**
9. Movie shop: The movies are rented out in stores and there are several stores. Each store has a unique distributor that supplies the store with tapes. A distributor may supply more than one store. Each distributor has a name, an address, and a phone number. Each store has a name, an address, and a phone number. For each employee we must keep the following information: working store, a name, a supervisor, an address , a phone number, SIN (social insurance number) and the date when the employee was hired. For each customer we have to keep the following information: a name, an address, and a phone number (if any). For each rental, we must keep track of which employee served the customer, which movie and which copy (i.e. type) the customer rented, information about payment, the date and the time of the rental, the status (rented, returned\_in\_time, returned\_late), the rate (i.e. the price), and if applicable, due date and overdue charges. About the payment we have to keep which of the employees accepted the payment (does not have to be the same employee who rented the tape), the type of payment (i.e. cash, check, credit card, direct debit – for each type you must provide for relevant information to be kept, e.g. credit card number if credit card is used), the amount of the payment, date + time of the payment, payment status (completed if cash or the money have been received, approved if debit or credit card go through, pending if the check has not cleared yet). About each tape we have to keep information in what condition the tape is and what movie is on the tape. About each movie we have to keep its title, director’s name, simple description, the name of a (single) major star, the movie’s rating. (**GRPA-5)**
10. Our company does car rental business and has several locations with different address (address consist of street or rural route with the number, city, province and postal code). The cars are classified as subcompacts, compacts, sedans, or luxury. Each car has a particular make, model, year made, and color. Each car has a unique identification number and a unique license plate. The cars rented in a particular location may be returned to a different location (so-called drop off). For every car we keep the odometer reading before it is rented and after it is returned. Since we trust our customers, we do not record the defect when the car is rent out and returned back. However, we rent the car with full tank and record the volume of gas in the tank when the car is returned, but we only indicate if the tank is empty, quarter full, half full, three quarters full, or full. We keep track of which day a car was rented, but not of the time, similarly for car returning. If a customer requests a specific class (say sedan), we may rent the customer a higher-class car if we do not have the requested class in the stock, but we will price it at the level the customer requested (so-called upgrade). Each car class has its own pricing, but all cars in the same class are priced the same. We have rental policies for 1 day, 1 week, 2 weeks, and 1 month. Thus, if a customer rents a car for 8 days, it will be priced as 1 week + 1 day. The drop-off charge only depends on the class of the rented car, the location it was rented from and the location it is returned to. About our customers, we keep their names, addresses, possibly all phone numbers, and the number of the driver’s license (we assume a unique license per person). About our employees we keep the same information (we require that all our employees have a driver’s license). We have several categories of workers, drivers, cleaners, clerks, and managers. Any of our employees can rent a car from our company for a 50% discount, if the rental is less than 2 weeks. However, for any longer rental they must pay 90% of the regular price. Every employee works in one location only. We have headquarters in Nairobi. The people who work there are all classified as managers, one of them is the president, two of them are the vice-presidents, one for operation, the other for marketing). **(GRPB-5)**
11. In our college, students need to register for courses before new semester start. All of programs in our college take four years to finish. Each course has a unique designation, title, description, year (in which year of study the course is to be taken, for instance 2nd year course), and classroom. A course can have no or many tutorial sections, and no or many lab sections. Each course is taught by exactly one instructor. Each instructor has a unique id, name, departmental affiliation, office room, phone extension, and a unique email address. Each student has a unique id, name, and the year of his/her study. A student cannot be an instructor. A course can have zero or many tutorial sections unique to the course (i.e. tutorial sections are not shared by different courses). Each tutorial section has exactly one TA assigned. A TA can tutor more than one tutorial section for the same course, and any number of tutorials for different courses. A TA cannot be an instructor, however a student can work as a TA (in that case his/her student id is used as TA id). A course can have zero or many lab sections unique to the course (i.e. lab sections are not shared by different courses). Each lab section has exactly one LA assigned. An LA can oversee more than one lab section for the same course, and any number of labs for different courses. An LA cannot be an instructor, however a student can work as a LA (in which case his/her student id is used as the LA id). In fact, a student can work as a TA and an LA simultaneously. Thus, a TA may or may not be a student, an LA may or may not be a student. A person can work as both, a TA and a LA. TA has the same attributes as instructor, the same goes for LA. Each course has zero to many courses designated as its prerequisites and zero to many courses designated as its anti-requisites. Prerequisite courses are of the same or lower year, anti-requisite courses are of the same year. In the system we keep information of what courses a student has taken and what courses the student is registering. All courses are either Pass or Fail. A student can register a course only if he/she has passed all the prerequisites and has not passed any or is not registered in any of the anti-requisites. A student can only register a course of the appropriate year, i.e. a student in year X of study can only register and take course of year X (**GRPA-6)**
12. In our Emergency Room (ER), we have three distinct types of workers: receptionists, nurses, and doctors. Any of the workers can in fact be a patient. Each person in the proposed system, be it a patient or a worker has a last, a first, possibly a middle name, and one or more addresses. An address consists of a country, province, city, street and street number. Each person can have none or more email addresses, none or more telephone numbers. The workers work in ER in shifts. A shift consists of start and end time. The shifts do not overlap, but they are consecutive, i.e. there is a shift on at any given time and day. We are assuming that the model we are creating (and eventually the database we will design) covers some extended period of time. Each worker will thus be assigned to many shifts in that period. Exactly two receptionists are assigned to each shift, a group of two or more nurses is assigned to each shift, a group of two or more doctors is assigned to each shift, one of the doctors assigned to a shift is the shift’s triage doctor. When a patient comes to ER, it happens during a particular shift. The patient is admitted by a particular receptionist, is seen by the triage doctor of the shift. The patient may be send home, prescribed some medication by the triage doctor and send home, or is staying in ER – in which case the patient is assigned a bed and case doctors (one of the doctors on each shift best qualified for the particular problem of the patient). Each bed is supervised by a single nurse during a shift, but a nurse may supervise many beds, or none at all. The case doctor(s) may prescribe a medication that is administered to the patient by a single nurse in each shift for the duration of the patient taking the medicine. Each medication has a name, and for each patient there may be a different dosage and different number of times a day to take it **(GRPB-6).**
13. Our website manages software projects for downloads to users. Each software project has a unique project id, can be assigned one or more categories (the categories are A, B ,C and D), has a status, and has a description. Some projects may depend on other projects and we keep track of the dependency. Each project is developed and owned by a single developer (who is our subscriber), and uploaded to our website in one or more transactions. Our users are identified by name, email and a unique user id. They can be either guest users or subscribed users (subscribers for short). The subscribers have passwords and we keep the date of the subscription. They need the password to access our website to file bug reports or upload software projects or update patches. A user can download any project, the number of downloads per user per project is recorded. The subscribers can file bug reports for any project. Every bug identified has an id and a description. The bug id’s must be unique for all bugs concerning the same project. The date of filing of a bug report is recorded. Each bug report deals with a single project and can report a single bug. Each bug report is made by a single subscriber. Some of our subscribers are developers. They develop the software projects and also software updates for their own projects. Each update for a project has an id, a name, a status, a description, and is assigned a particular type (the type are 1, 2 and 3). Each update for a project is created by a single developer, the one who originally created the project. Each update patch is uploaded to our website in a transaction. Each transaction has an id and a date when it took place. The transaction id’s must be unique for all transactions concerning the same project (**GRPA-7)**
14. Our company has several warehouses, each warehouse is designated by a unique 4-letter symbol (by a letter we mean a..z and A..Z). Each warehouse has several bins that are identified uniquely by numbers , i.e. each warehouse has bins 0, 1, 2, 3, ... Each bin has a particular capacity. In our warehouses (more precisely in the bins in our warehouses) we store parts. Each part is designated by a unique part number (a 5-symbol sequence of digits and letters). Several parts together can form another part. We call such a part “assembly”. In the warehouses we store only the constituent parts, but we record the assemblies in our database as it were a part. Assemblies cannot be parts of other assemblies. A part can be a constituent part in at most in one assembly parts arrive in batches. Each batch for a particular part has a unique batch number and arrives on a particular date. Each batch has a size, i.e. the number of items in the batch. All items from the same batch are stored together in the same bin (no batch is stored in more than 1 bin). Each item in a batch has a unique item number (unsigned integer). For example: part A1, batch 27, item 1 or part A1, batch 23, item 1 etc. When a batch arrives, its date-in is recorded. A particular manager checks its arrival, and this fact must be recorded in the database. Some parts may be backordered. A part can be backordered only by a manager. The manager, the date of the backorder are recorded, and also the quantity backordered. When a backorder shipment arrives, the backorder’s remaining quantity is updated (the number of items arrived is subtracted from the remaining quantity), and if it is less or equal to 0, the backorder is deleted, but must be kept for record. There may be only a single current (active) backorder for any parts. Assemblies cannot be backordered, only their constituent parts. When an item is shipped out of the warehouse, its date-out is recorded together with the employee who checked its shipping. Employee has a unique employee number (a 6-digit number), phone number(s) (it consists of a 3-digit area code and a 6-digit number an employee can have 0 to many phone numbers), name(s) (it consists of an up=to-10-characters fist name, an up-to-10-characters middle name, and an up-to-20-characters last name, an employee can have 1 to many names), address(s) (it consists of an up-to-6-characters street number, an up-to-20-characters street name, an up-to-20-characters city name, and a 2-character abbreviation of the province, an employee can have 1 to many address). Some of the employees are managers. Every employee who is not a manager works under supervision of a single manager. Managers do not work under other managers. **(GRPB-7)**
15. A university has a large number of courses in its catalog. Attributes of a course include Course Number, Course Name and Units. Each course may have one or more courses as prerequisites or may have no prerequisite. Similarly, a particular course may be a prerequisite any number of courses or may not be a prerequisite for any other course. The university adds or drops a prerequisite for a course only when the director makes a formal request to that effect.(**GRPA-8**)
16. A garbage collection company wishes to have a system for its operations. The company maintains the following about its clients ClientName, Phone Number, and physical address (EstateName. StreetName, HouseNo). Every end month, the company wishes to be sending billing messages to its clients communicating the Amount due, any arrears or over payments. A remark is also necessary to indicate any complaints or comments concerning the service. Once payments are done, the company prints receipts for the clients indicating amount paid, payment date and clientName.(**GRPB-8**)
17. A sports club allows interested persons to register for membership. Details include Name, PhoneNumber, Email Address, Age, Gender. A person can register under various membership categories Gold, Silver or Bronze which attract varying annual membership fee and varying privileges. The club plans various events for its members in their categories at different times of the year and communicates the same through emails. At every end of the year, the club holds a common dinner where all members re-unite and renew their annual membership. (**GRPA-9**)
18. The Topi school of business operates international business programs in 10 locations throughout Europe. The school had its first class of 900 graduates in 1965.The school keeps track of graduates student number, name of student, year when student graduated, country of birth, country of citizenship and name of each major the student completed (each student as one or two majors).The school holds various events around the world to keep ties with the alumni. Events have title, date, location and type e.g. dinner, seminar. The school needs to keep track of which students attended which events. For an attendance, a comment is recorded about information that school official learnt from the graduate. The school contacts the graduates either by email, telephone, fax or mail.**(GRPB-9**)