

Semantic Data Modeling and Applications SS 2023

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1

Group		
Name	MatNr.	SKZ.

Exercise 1 4 Points Submission: 05.06.2023

Discuss the most important reasons for introducing extensions of the Entity-Relationship model.

Exercise 2 5 Points Submission: 05.06.2023

Describe in detail the most important advantages of object-oriented data modeling.

Exercise 3 12 Points Submission: 05.06.2023

Describe in detail the purpose of UML use case diagram, class diagram, package, and state diagram including a simple example for each.

Exercise 4 15 Points Submission: 05.06.2023

DBMS Schema

A DBMS schema consists of relations (with attributes and their domains) including their integrity constraints and views.

Triggers, which consist of the definition of triggering events and one or more constraints (referential constraints and check constraints to enforce data integrity rules), can activate application functions. If such a condition is fulfilled (TRUE), certain actions (database transactions) are executed. In addition to information objects, time can also be a triggering event for a trigger.

An event can activate multiple triggers. A trigger can be activated by several events.

User access is granted through passwords. Users with the same permission profile have an identical password. The permission profile defines the access authorizations at the attribute level.

Create a GSM for the requirements specification. Consider the associations, relevant attributes and key attributes of the concepts.

Exercise 5 15 Points Submission: 05.06.2023

Scientific Publications

Scientific publications (title, classification) are classified as books, proceedings (conference proceedings) and journals. Books are published by a publisher (name, address), are written by at least one author and may belong to a book series (title, editor, and publisher).

A paper is part of either a proceeding or a journal and is written by at least one author (first name, last name, address). Authors may be part of a research group (name, address) and are interested in various research areas. Several topics can be assigned to a research area, but an individual topic can only be assigned to one specific research area. In most cases, more than one topic is assigned to a publication or a paper.

A researcher (first name, last name, title, date of birth, place of birth, address) may either buy or borrow (date of borrowing) publications. A researcher can invite an author to write a paper.

Create a UML class diagram (database schema) for the database relevant concepts of the requirement specification.

Exercise 6**6 Points****Submission: 05.06.2023**

State Diagram Digital Watch

A digital watch mainly consists of a display and two buttons (button A and button B) for manually setting the clock. The watch has two different operation modes: display time and set time. The display time mode shows the current hour and minute. A flashing colon separates hours and minutes. The set time mode is divided into two sub-modes: set hours and set minutes. Button A allows selecting the sub-mode. Each press of the button A changes the mode alternately and the following sequence applies. Display: set hour, set minute, display time. In a sub-mode each press of the button B changes either hours or minutes by one increment. The buttons have to be released before another event may be triggered.

Create a UML state diagram for the digital watch.

Exercise 7**15 Points****Submission: 05.06.2023**

Law Firm Information System

The office of a law firm is organized in several departments and a chancery. An employee works either in a department or in the chancery. The chancery manages a file plan (file plan number and description).

Incoming postal items (e.g., letters from external business partners) are opened in the chancery and electronically recorded by a scanner. Depending on its subject, a postal item is assigned to a file number (file plan number + sequential number). After assigning a file number, a new file is created. Of course, several postal items can be assigned to one file. In addition, a postal item is described by attributes like date of deposit, and number of external law firm. A department and an affiliated employee of this department are assigned to a file. Afterwards, the file is sent electronically to the responsible employee, who will then select an appropriate file process from the existing set of predefined standard file processes. In the next step, the employee adapts the selected standard file process by considering the specific requirements of the current file. A file process defines the processing sequence (workflow) of activities executed by the employees. The responsible employee selects these activities from a predefined catalog, e.g., start processing, ready for completion, ready for approval, before dispatch, before depositing and filing). Finally, the file is distributed electronically according to the specified file process.

It has to be logged and recorded (date and time) when an employee receives a file for processing and when this employee sends the file to the respective successor employee according to the sequence defined in file process.

The law firm's information system has to provide at least the following functions: management of master data (department, employee, file process, and file), definition of standard file processes, definition of real file processes including logging information of employees' workload, and finally statistics (Which employee currently processes which file? / Who is responsible for which file?, ...).

Create a UML class diagram (database schema) for the database relevant concepts of the requirement specification.

Exercise 8**15 Points****Submission: 05.06.2023**

Manufacturing Industry II

A manufacturing company designs and produces technical products. A product is composed of several sub-products. For each individual product three different employee types, a developer, a designer, and a product manager, are responsible during the product lifecycle. A customer places several orders consisting of a purchase order number, a date and order positions referring to a product.

After the production process, each product is given a serial number. This serial number is documented at delivery, referring to a specific customer order. To fulfill an order, more than one delivery can be necessary, but it is not allowed that several different orders are fulfilled by one delivery. A delivery position refers to exactly one manufactured product.

Create a UML class diagram (database schema) for the database relevant concepts of the requirement specification.

Exercise 9**20 Points****Submission: 05.06.2023**

Library Management System

A library intends to implement a management system for books, a local borrowing system (no inter-library loan), as well as a procurement system for new books.

The library is distributed over several different locations. Each location has various rooms, which are located in different floors. Each room contains unique identifiable shelves. In the future, the library may expand into new locations, rooms and shelves. Currently available locations, rooms and shelves may be closed or removed through adaption over time. This information is centrally managed by the system administrator. For all employees of the library, name, address, email, and their role (subject editor, borrowing service, and book service) are stored. Employees of the book service may also serve as substitutes for their colleagues in the borrowing service and should therefore be authorized to access all functions of the borrowing system.

Library users, which borrow books, must register in the system. During registration, the employee of the borrowing system enters the following user data: name, status, postal address, email address, and phone number. The user status grants the borrowing rights (reading room, short-term borrowing, and long-term borrowing). After successfully logging in, a user ID barcode label is printed and stored in the system. Users that lose their membership are deleted from the system.

The system should come with a user interface that provides a search engine for all publication types (books, journals, master's theses, and PhD theses). Search results should be printable in various formats.

Library users hand over an order ticket to an employee of the order service, who enters the borrowing order into the system. If the publication is already borrowed, the user can place a reservation for this publication. The reservation is again processed by the borrowing service.

Every hour the book service receives a printed list of all borrowing orders. Publications that are stored at the same location, where the borrowing order is placed, are directly handed over to the library user. Borrowing orders for publications at other locations are forwarded to the respective library, and are available on the next working day. The user's borrowing register contains all borrowed publications. Each publication handed over to the user is registered by the publication barcode. Upon return, the publications are deleted from the borrowing register.

The system automatically generates reminders, if the borrowing time exceeds the loan period. Payment reminders are stored in the database, in order to charge reminder fees upon return of the publication.

When a new book is included and listed in the library, an employee of the book service enters all relevant data in the system, including the book's location. For each book, a book ID barcode label is printed and stored in the system. Finally, a specific subject area is assigned to the book. The subject editor, who is responsible for a subject area, provides help and answers questions concerning this area. Subject areas are centrally managed by system administrators. Books that get lost or are removed by various reasons should be deleted in the system. In particular, for master's theses and PhD theses, it should be possible to store an electronic version in the system.

Subject editors are authorized to order new books for the library. For that purpose, all relevant data of a book must be entered into the system. All orders are centrally stored in the system.

Book service employees receive a collection of all orders placed by subject editors. The library information system has to support complete traceability and statistics for orders (open orders, sent orders, all orders of the current year, orders by subject editor ...). Each generated order list has to be printable (e.g., to send it to a bookstore). The order status (ordered, sent, received, finished) is changed continuously. Finally, an order must be deleted from the order collection if, for example, the book is already ordered.

Create a UML class diagram (database schema) for the database relevant concepts of the requirement specification.

Exercise 10

25 Points Submission: 05.06.2023

Airport Control System

A regional airport intends to establish an airport control system, which monitors all movements of airplanes and vehicles on the guideways and other routes of the airport. For possible accidents on the guideways or routes, emergency plans shall be provided, which can be created by using the system.

Initially, an administrator describes the entire route network of the airport, in order to track all movements of airplanes and vehicles on this route network. The route network consists of paths, crossroads and parking positions. For a path an identification number, its length and description are stored. A number and type (ramp, bus stop) describe a parking position. A unique number identifies a crossroad. A status (free or occupied) is dynamically assigned to each part of the route network at runtime. A path leads either to two crossroads (at the beginning and end of the path) or to a crossroad and a parking position, but never to two

parking positions. An arbitrary number of paths can lead into a crossroad. Each runway contains at least one crossroad.

Before landing, each airplane announces itself to the system. After landing, the airplane moves to an assigned parking position. During a start procedure, each aircraft moves from its parking position over the route network to the runway. After a successful takeoff, the airplane logs off the system. Logging on / off of the aircraft can also be performed by the airspace monitoring system (redundancy increases safety).

The administrator also defines the flight plans, the descriptions of the planned flights, and the scheduled movements of flights at the airport. A flight plan has a name, a date of creation and the frequency of the flight (charter flight, daily, weekly or monthly). Each flight plan is assigned to exactly one aircraft type (weight, range, capacity). If a desired aircraft type has not yet been defined in the system, it must be created before an assignment. When creating a flight plan, the administrator can also define all movements assigned to this flight plan.

The system also manages all vehicles moving around the airport. For each vehicle, its vehicle registration number, maximum speed, and vehicle type are stored (e.g., bus, tanker, etc.). The movements of the vehicles cannot be predicted and are therefore not statically predefined.

Any movement of an airplane or vehicle, which is statically predefined or registered during operation, consists of partial movements. Each partial movement has a predecessor and a successor, except for the first and last partial movement (e.g., takeoff or landing, arriving or departing from a parking position). Each partial movement leads from one part of the airport to the next adjoining part (e.g., from a parking position to a path, from a path to a crossroad). By the sequence of such partial movements, the entire movement of a vehicle from one point to another or the start (movement from the parking position to takeoff) or landing (landing and movement to the parking position) of an aircraft can be precisely described.

Any movement of an airplane or vehicle must be approved by an operator. As mentioned above, for an airplane the movements are already predefined in the system, and therefore they are only communicated by the operator to a flight. Vehicles announce the desired movement to the operator. The operator can approve or deny this movement, in case of the risk of a collision. The operator is also authorized to change the desired movement (only starting position and destination must remain unchanged) or delay the movement of the vehicle up to an uncritical time.

During operation, the data of each current flight that carries out its predefined flight plan is managed (flight number, departure time, estimated time of arrival, number of passengers, weight). The current position and movement status (starting, landing, standing or driving) of each airplane and vehicle are continuously updated in the information system.

Sensors continuously collect data of the current position of all airplanes and vehicles and transmit them to the information system by using a uniform interface. The aircrafts and vehicles themselves announce their position at regular intervals by radio. For safety reasons on one part of the route network, only one airplane or vehicle is permitted at the same time. The system continuously checks all incoming position messages and reports an imminent collision by an alarm. Airplanes and vehicles can also trigger an alarm if either a sensor, a pilot, a driver or the operator detects a dangerous situation. In the event of an alarm, the operator must also take the correct action according to the alarm plan.

For alarm planes, their designation and a brief description are stored. Each alarm plan consists of a number of interventions (individual measures), which are also described in the system. Each of these interventions has at least one emergency unit assigned. There is also a responsible person for each alarm plan defined. Each responsible person has several subordinate responsible persons who, in turn, are responsible for an emergency unit. An emergency unit has assigned its vehicles, so that the current position of each vehicle

and the emergency unit can be determined quickly in an emergency situation. An administration can transfer all data from the alarm planes and the associated data (except the data of vehicles) from an external system to the internal airport control system.

Create a UML class diagram (database schema) for the database relevant concepts of the requirement specification.

Exercise 11

20 Points Submission: 05.06.2023

Rock Climbing Web Portal

A new web portal for rock climbing and the relevant information as well as results from national and international competitions is established. The system offers information about climbing areas (indoor, outdoor) and their climbing routes as well as a discussion forum for active climbers.

Climbing areas are outdoor or indoor and consist of several sectors in which the individual climbing routes are located. For each climbing area, the unique name, type of rock or wall (granite, limestone or artificial wall) and a route description are stored. If the climbing area is a climbing hall, the admission fee, opening hours, address, location and telephone number as well as a contact e-mail address and homepage (if available) are also stored. Each climbing area is divided into one or more sectors. Sectors are identified by a unique name and optionally provide information about times, in which climbing is not allowed (due to nature protection reasons), the geographic direction of the wall, and a brief description of the entrance (ascent). Additionally, information about expected climbing characteristics (overhanging, slab climbing, drilled pockets, traverses, alpine) and available types of climbing protections (bolts, pitons, no belaying) as well as information about the last renovation of the wall (if available) is stored. Each sector offers at least one climbing route.

For a climbing route the name, the degree of difficulty (a combination of a number equal or greater than 1 followed by +/-, depending on the grading system), the length of the route, the number of belay anchors, and a rating (on a scale of 1 to 5) as recommendable the route is are stored.

An administrator is responsible for the content management (insert, update, delete). Anonymous visitors of the website can search for climbing areas, sectors, routes, competitions or climbers (in order to list them and to get detailed information), evaluations about climbing areas and climbers as well as reading the most important news of rock climbing. News about rock climbing as displayed in the news section of the internet portal are stored with their date, corresponding text and hyperlink. If the news is related to a climbing area, competition or climber, detailed information about the corresponding data record is available in a separate window. The news is edited by employed online-editors.

Web portal visitors can register in the system by providing their full name, date of birth, password and their email address. After the successful registration, an account is generated automatically and a confirmation is sent by e-mail to the new user (with an automatically generated userID).

After successful login, a user who is an active climber can enter the ascent of a stored route (date of ascent, optionally the number of attempts, as well as a personal comment on the route). In order to simplify the search of climbing routes for ascents, first a user has to search the climbing area and the sector in which the route is located. A user can of course update and deleted data about ascents and other user-generated

content later. The extended data of a climber also includes one or more favorite climbing areas and/or favorite climbing routes, each with a brief explanatory statement.

Registered users can additionally participate in online discussions. First, a discussion category (unique name, creation date) pre-defined by an administrator must be selected, and afterwards the user can write a new contribution or write a reply to an existing post.

Club officials, who receive a special account after oral request, are authorized to maintain information on competitions (title, start and end date, contact details as well as a link to the homepage of the competition). Several competitions can also be combined into a cup (unique name, year, description).

Club officials can also prepare result lists of a competition in the system. Result lists contain the rank of all participating climbers after the qualification as well as the final rank (final placement). If the results of a climber who has not yet been stored in the system are entered, the climber's data is automatically saved. If a user account with the same climber name is registered later, already existing data is automatically assigned. In the case of assignment conflicts (several identical names), these are manually resolved by an administrator.

Create a UML class diagram (database schema) for the database relevant concepts of the requirement specification.

Exercise 12

25 Points Submission: 05.06.2023

Formula One Management

Formula One (F1) management decides to set up a new information system to keep track of the results of all the seasons since the first Formula One World championship in 1950.

Formula One (also Formula 1 or F1 and officially the FIA Formula One World Championship) is the highest class of single-seat auto racing that is sanctioned by the Fédération Internationale de l'Automobile (FIA). The "formula" in the name refers to the set of rules to which all participants' cars must conform. A Formula One season consists of a series of races, known as Grand Prix, which are held worldwide on purpose-built circuits and public roads.

The results of each race are evaluated using a points system to determine two annual World Championships, one for drivers, one for constructors. Currently, a championship consists of 21 races in a season.

A race (Grand Prix, e.g., with the name "Austrian Grand Prix") takes place on a circuit assigned to a city, nation and continent (e.g., Spielberg, Austria, Europe). A circuit has a name (e.g., "Red Bull Ring"), a track length, a certain number of turns, an opening date, and active years (e.g., 1950, 1955–2018 for Monaco Grand Prix). Circuit name, track length, and number of turns may change over time. For example, the name of the circuit for the Austrian Grand Prix was "Österreichring" from 1969 to 1976 and was renamed to "Red Bull Ring" in 2011.

For each race, the official name (e.g., "Formula 1 Großer Preis von Österreich 2018"), the date, the number of finished laps, the weather conditions (e.g., "wet race"), and a description are stored. Additionally, the fastest lap ever driven (driver, year, and lap time) is stored.

A team has a team principal, a technical director, two main racing drivers and optionally one or more test drivers. For a team the full name (e.g., Scuderia Ferrari), license nationality (e.g., Italy), and the location of the base (e.g., Maranello, Italy) are stored. Chassis (e.g., SF71H) and engine (e.g., Ferrari 062 EVO) are stored for a team per season.

For a constructor (team) two racing drivers take part in a Grand Prix. Racing drivers are stored with the attributes name, date of birth, nationality and the starting number. The starting number can change across the championships.

For each driver, statistics about the number of races, pole positions, race victories, podium positions and total GP points in the current world championship are available. Thus, for each race, starting and final driver position must be stored as well as the fastest lap (consisting of driver, lap number, and lap time) and optionally a reason for disqualification or retiring. At the end of a season, the driver with the highest GP score becomes World's Driver Champion, and the team with the highest score World Constructors' Champion. The starting position is determined by the qualifying race, which usually takes place the day before a race. The results stored for a driver participating in the qualifying session are the position and the time realized for the three qualifying parts (called Q1, Q2, and Q3).

The tires play a significant role in the performance of a Formula One car. Since 2007, all participating teams are required to use the tires from the sole tire supplier (e.g., Pirelli), who can however change across championships. In 2020 the current tire supplier offers seven different types of tire compounds (C1 hard, C2 medium, C3 soft, C4 ultra-soft, C5 hyper-soft, intermediate and wet) for which name, code, color code, tread (slick, treaded), driving conditions (dry, wet), grip level, and durability are stored. The driver must select and use at least two and a maximum of three different tire compounds for each race. For regulation adherence, the order of the driver's tire selection has to be stored to determine the number of laps and in which lap a tire compound was in use.

Create a UML class diagram (database schema) for the database relevant concepts of the requirement specification.

Create an OWL ontology in Protégé (<https://protege.stanford.edu/software.php>). Submit a graphical representation of the ontology and the corresponding OWL file electronically by email to wolfram.woess@jku.at.

Pizza tutorial: <http://protegewiki.stanford.edu/wiki/Protege4Pizzas10Minutes>.

Exercise 13

25 Points Submission: 05.06.2023

Tourism Ontology

A tourism destination (city, town or village) offers sights, museums, famous and outstanding buildings, places, events (e.g., festivals, concerts, sports events ...) and numerous other attractions as well as hotels, rated by 1 to 5 stars.

A hotel offers different room categories (deluxe, superior or standard room) with different room size (e.g., single room, double room, suite ...). Beside the guest rooms, a hotel offers several in-house and external leisure activities, e.g., mountain biking, golf, hiking or swimming in the hotel pool. For in-house leisure activities, the hotel must provide the required leisure facilities (e.g., in-/outdoor pool for swimming).

An event has an opening time, closing time, and a contact address (email and postal address). Hotels and sights have an address, consisting of street, number, zip code, and country.