Examination

Course:	Spatial Databases and Infrastructures	22.02.2019
Semester:	Winter Term 2018/2019	
Name:		
Student ID:		

1: Introduction (8 points)

a) Explain the terms database management system, database, and database system and draw a figure that illustrates how they are related. (4 points)
b) What advantages does it have to manage data in a database as opposed to in files? (3 points)
c) Name the three database models that are predominantly established in practice. (1 points)

2: UML (15 points)

In your future job, your task is to create a conceptual model for soccer clubs in UML. Many different persons are working in a soccer club like players, coaches, and managers. There are usually not only one, but several soccer teams that belong to one club. Each club has one stadium.

Create a conceptual model for soccer clubs in the form of a UML diagram incorporating the above information. Enrich this model with only a few, but meaningful attributes. Integrate the relationships between the individual classes as mentioned in the lecture and give a short textual explanation why you have chosen a specific relationship. Please integrate at least one geometrical attribute.

3: Relational Data Model (10 points)

a) Annotate the boxes in the following figure, which shows the structure in which data is stored in a relational database. Provide both the relational terms (the ones that are written in the brackets in the lecture slides) as well as the more practically oriented terms. Also provide information on how often these structural elements occur. (4 points)
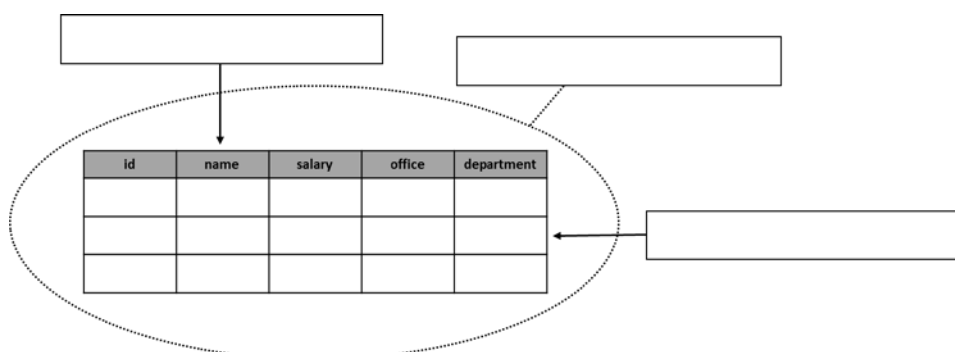
b) Name the three fundamental operations of the relational data model. Provide example queries in SQL and highlight the relevant parts that correspond to each fundamental operation. (3 points)
c) What is a transaction (in the context of databases) and what is meant by the ACID paradigm? (3 points)

4: Simple SQL Queries (15 points)

As an employee working in the IT department of a large fast food chain, you are to set up a database to manage all restaurants.

a) Specify the SQL query that is used to generate the following table named "restaurants". Note that in position the location of a restaurant should be stored as point geometry. (3 points)

id	manager	location	num_employees	opening_year	annual_turnover
85	Tom Reynolds	(100, 200)	17	2014	5,094,345€
117	Carlee Sharp	(300, 75)		2019	

b) The restaurant with id 117 is newly opened and some information is not available yet. How must the SQL query for inserting the restaurant with id 117 be specified? Remember that position holds the 2D coordinates as a point geometry. (3 points)

c) How can you ensure that the table is valid with regard to the following conditions? The information of id, manager, location and opening_year must always be entered and cannot be omitted. Since our chain was established in 2005, the opening date of its restaurants must always be in the year 2005 or later. (3 points)

d) Suppose all 135 restaurants of the chain are managed in this table. Create an SQL query that returns the id, the opening year, and the turnover per employee. (3 points)

e) Provide an SQL query that returns only the restaurants opened after 2010 with an annual turnover higher than 3,000,000€. (3 points)

5: Advanced SQL Queries (8 points)

The following table, named "exp_per_dep", shows the expenditure per department (for a fictional enterprise):

position	department	responsible_person	payment
1	R&D	John Doe	15,953€
2	Marketing	Katie Marsh	94,627€
3	Manufacturing	Glen Reynolds	38,900€
4	R&D	Carlee Lawrence	7,084€
5	R&D	John Doe	54,346€
6	Manufacturing	Tom Ward	1,874€
7	Marketing	Sienna Mercado	77,103€
8	Human Resources	Cael Sharp	27,006€

a) Define an SQL query that returns the number of payments. Or in other words, how many payments were issued altogether by the company. (In the table above, there are 8 payments!) (4 points)

b) Specify an SQL query that returns the total amount of payments for each department. (For example, the human resources department has total payments that amount to 27,006€.) (4 points)

6: Normalization (5 points)

a) Give a small example of a table that is <u>not</u> in first normal form. (2 points)
b) Why is the following table not in second normal form? (3 points)

manufacturer	model	submodel	country
Audi	TT	TT Roadster 8N	Germany
Honda	Civic	Civic Coupé	Japan
Ferrari	Gallardo	Gallardo Spyder	Italy
Renault	Mégane	Mégane Coupé	France
Renault	Espace	Espace IV	France
Audi	A6	A6 allroad quattro	Germany
Toyota	Corolla	Corolla Sport	Japan

7: Geometric Classes in Simple Feature Access (8 points)

Which geometry classes can be used to represent the following figures according to the simple feature access model? Is the class unique for each figure or are there several possibilities? (5 points)

(a)   (b)   (c)   (d)   (e)   (f)
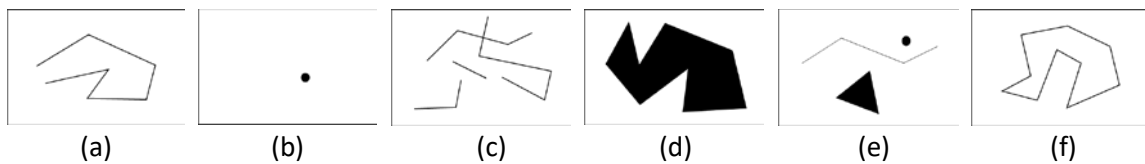
Depict the interior and boundary of the following geometric figures. (3 points)

(g)   (h)   (i)
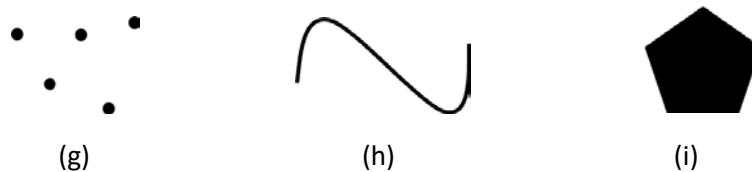
8: Queries on Line-Like Geoobjects (10 points)

Assume a database table named "rivers" that stores a number of rivers with their identifier (ID), name, source, some other thematic attributes, and their geometric shape as a linestring. There are no river branches or junctions.

a) Specify an SQL query that returns the name, source, and length of each river in the table.
   (2 points)
b) Change the query so that only one data set is returned with the total length of all rivers. Can we still get the name and source of the individual rivers with this query? Explain! (3 points)
c) Name two aggregate functions for geometry and briefly describe what they do. (3 points)
d) At the time of a high water, each river will flood 50 meters inland. How could you query the total area of the entire flooded catchment region? You do <u>not</u> need to provide the SQL query. (2 points)

9: Spatial Joins (8 points)

Note that for the following sub questions, the geometric attributes are named "geom" in all tables. All tables contain a number of thematic attributes that should all be returned by the queries.

a) Assume there are two tables, one for restaurants with point geometry and one for highways with linestring geometry. Not all restaurants are close to highways. Give an SQL query that returns all restaurants that are within a distance of 200m from any highway. (4 points)

b) Assume there is one table for cities with point geometry. Provide an SQL query that returns the distance of each city to all other cities. What kind of join is this (besides a spatial join) ? (4 points)

10: The 9-Intersection Model (8 points)

a) Describe in your own words the 9-intersection model (9IM). What is its purpose and how is the computation carried out? Provide a self-chosen example that includes a drawing. (4 points)

b) Give the result of the dimension extended 9-intersection model (DE 9IM) for the spatial objects A and B that are depicted in the following figure: (4 points)
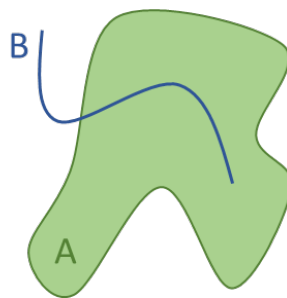
11: R-tree (13 points)

a) Start with an empty R-tree and gradually insert the following 7 polygons into this tree (m=2, M=3). Try to keep the spatial expansion of the tree elements as small as possible. Draw the resulting R-tree after each step. Only for the final R-tree, draw the extent of the inner vertices of the R-tree. (7 points)
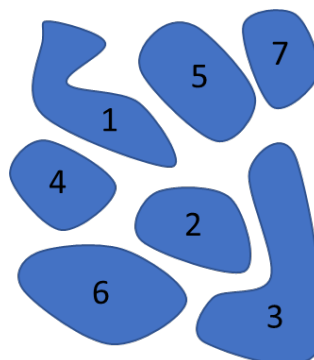
b) Name the two general steps of a point (or window) query using a spatial tree index (like the R-tree) and explain them briefly. (3 points)

c) How is it determined if a given point is located within a polygon of the R-tree or not? (3 points)

12: Spatial Data Infrastructures (12 points)

a) Explain the term interoperability in the context of spatial data infrastructures. (3 points)

b) Name three OGC web services that provide spatial data, explain their differences, and provide a conceptual drawing that displays the services in a practical arrangement. (4 points)

c) Give an example of a software application that provides the services mentioned in b). (1 point)

d) How can you determine what kind of data a web service provides, in which format, etc.? (2 points)

e) What can you do with filter encoding? Give an example! (2 points)