CSci 5715, Fall 20: Homework 1

Team No.: 1

Table of Participation

Question ID	Answer drafted by	Answer reviewed by
1	Group 1	
2	Group 1	
3	Group 1	
4	Group 1	
5	Group 1	

Chapter 1: Introduction to Spatial Databases

Answer **one** of the following choices for question 1 (limit 200 words):

Q1 (Choice A): The internet creates a virtual world where people can meet friends (e.g., Hangouts), watch movies (e.g., Netflix), take courses (e.g., Coursera), share and edit notes together (e.g., Google Docs), go shopping (e.g., Amazon.com), and visually explore places (e.g., Hololens) irrespective of locations. Does geography still matter? Justify your answer.

Geography is still very much relevant in today's world. Some proofs for this statement are the booming airline and travel industry (pre-COVID19) and the subsequent fall in the economies of most countries due to lockdowns around the world. Even though the internet is trying to offer the above mentioned facilities and experiences, the access to good internet network is still highly dependent on the geographic location of a person. And such facilities and experiences are also regulated (recent example of TikTok, WeChat) by individual goverments, which again depends on the location. Globalization has enabled catering to the specific needs of billions of different people, and accelerated the growth of economies to a scale never before seen in history. Indian pharma exports, American technology exports, Chinese smartphone exports, European automotive exports, Middle Eastern oil exports etc, are made possible due to the geography of these places and the countries taking advantage of their natural and manmade resources (land, labor and capital). The price of a good therefore depends on your geography, and activities such as taking courses online will be very different experiences for people around the globe.

Q1 (Choice B): The fastest ocean liner crossed the Atlantic in 3 days and 12 hours in 1950s, while today's flight from London to New York only takes 7 hours. Some people claim the death of distance. Do you agree? Justify your answer.

Q1 (Choice C): Online games can be played in teams using web portals (e.g. Steam), or within a huge community of gamers as in Massively Multi-player Online Gaming (MMOG). Does the virtual team activity provide similar experience and coordination opportunities as the physical team activity. Use the data from the following article to justify your answer.
"What Makes Teens Happier", Jean M Twenge Ph.D., Aug 31, 2018.
https://www.psychologytoday.com/us/blog/our-changing-culture/201808/what-do-happy-teens-do

Q2: Given the map of the state-level mortality rate of COVID-19 deaths in the USA, answer the following questions.

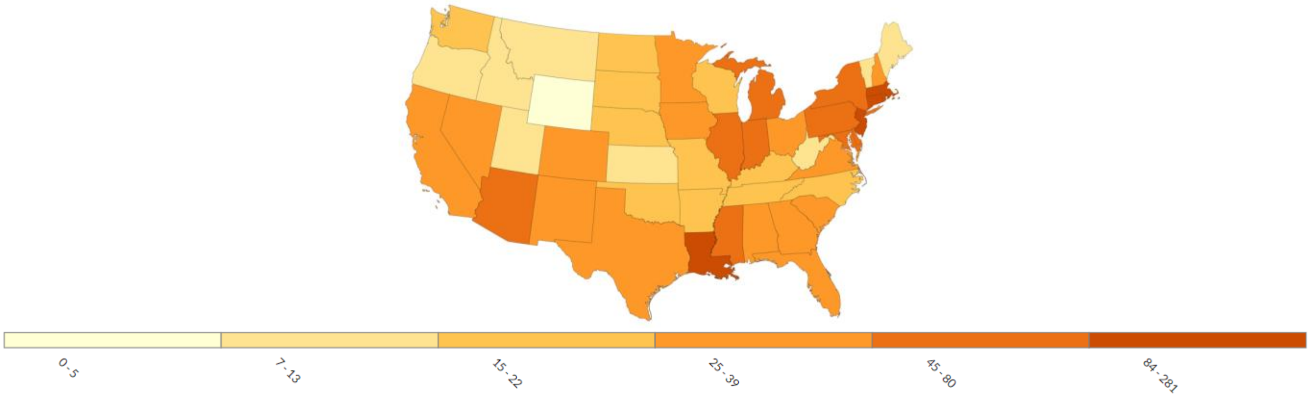
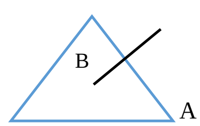
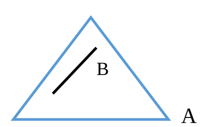
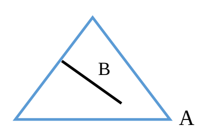
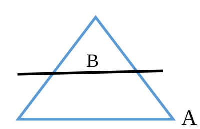
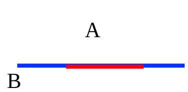
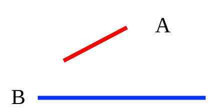
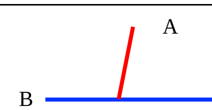
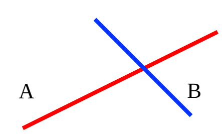


Figure1: COVID-19 Death Rate in the US Reported to the CDC, by State/Territory (deaths per 100,000)

What type of operations (local, focal, or zonal, global) should be used to answer the following queries?

Query	Type of Operation
2a. How many cells have mortality rate higher than 26.5 and lower than 38.2 per 100K people?	global
2b. What is the mortality rate of the state of "Minnesota"?	local
2c. If a state has a morality lower than 5, but all its neighbors have morality rates higher than 5, we consider it as a spatial outlier. Which states are spatial outliers?	focal

Q3: Fill out the following form with Boolean nine-intersection matrices each with two spatial objects namely A and B. In the upper row, A is a triangle, B is a line. In the lower row, both A(Red) and B(Blue) are lines. The boundary of a line is its end points. **(1 = T, 0 = F)**

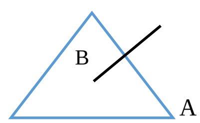
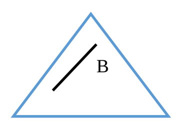
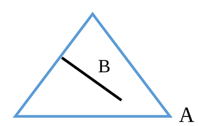
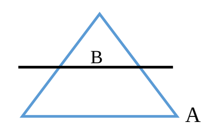
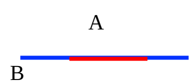
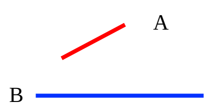
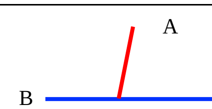
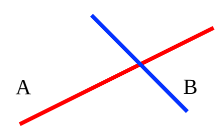
Map				
Boolean nine-intersection matrix ($\Gamma_9(A,B)$)	T T T T F T T T T	T T T F F T F F T	T T T F T T F F T	T F T T F T T T T
Map				
Boolean nine-intersection matrix ($\Gamma_9(A,B)$)	T F F T F F T T T	F F T F F T T T T	F F T T F T T T T	T F T F F T T T T

Q4: The dimension-extended nine-intersection model: DE-9IM extends Egenhofer's nine-intersection model introduced in Chapter 2. The template matrix of DE-9IM is shown below.

$$\Gamma_9(A,B)=\begin{pmatrix}\dim\,(A^{\circ}\cap B^{\circ}) & \dim\,(A^{\circ}\cap \partial B) & \dim\,(A^{\circ}\cap B^{-})\\ \dim\,(\partial A\cap B^{\circ}) & \dim\,(\partial A\cap \partial B) & \dim\,(\partial A\cap B^{-})\\ \dim\,(A^{-}\cap B^{\circ}) & \dim\,(A^{-}\cap \partial B) & \dim\,(A^{-}\cap B^{-})\end{pmatrix}$$

The key difference between 9IM and DE-9IM is that instead of testing whether each entry in the matrix is empty or nonempty; in the DE-9IM only the dimension of the geometric object is required. The dimension of planar two-dimensional objects can take four values: -1 for empty-set, 0 for points, 1 for lines, and 2 for nonzero area objects.

4a. Fill out the following form with **dimensional** nine-intersection matrices each with two spatial objects namely A and B (same objects as in Q3). In the upper row, A is a triangle, B is a line. In the lower row, both A(Red) and B(Blue) are lines. The boundary of a line is its end points:

Map				
Dimensional Nine-intersection matrix ($\Gamma_9(A,B)$)	$\begin{bmatrix}1&0&2\\0&-1&1\\1&0&2\end{bmatrix}$	$\begin{bmatrix}1&0&2\\-1&-1&1\\-1&-1&2\end{bmatrix}$	$\begin{bmatrix}1&0&2\\-1&0&1\\-1&-1&2\end{bmatrix}$	$\begin{bmatrix}1&-1&2\\0&-1&1\\1&0&2\end{bmatrix}$
Map				
Dimensional Nine-intersection matrix ($\Gamma_9(A,B)$)	$\begin{bmatrix}1&-1&-1\\0&-1&-1\\1&0&2\end{bmatrix}$	$\begin{bmatrix}-1&-1&1\\-1&-1&0\\1&0&2\end{bmatrix}$	$\begin{bmatrix}-1&-1&1\\0&-1&0\\1&0&2\end{bmatrix}$	$\begin{bmatrix}0&-1&1\\-1&-1&0\\1&0&2\end{bmatrix}$

4b. Find the **Boolean** 9-intersection matrix and **dimensional** 9-intersection matrix of the following relationships (a) and (b):
(a) Object A: Otter Tail county; Object B: Minnesota - contains
(b) Object A: Italy; Object B: San Marino - touch
Search online for the information of these places. (Hint: Hennepin County is part of Minnesota. San Marino is not part of Italy)

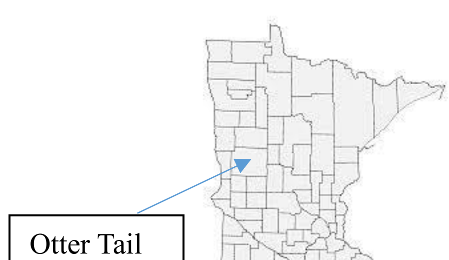


Figure2: A map of Otter Tail County and Minnesota

(a) A: Otter Trail county, B: Minnesota

Boolean:

	I(B)	B(B)	E(B)
I(A)	T	F	F
B(A)	T	F	F
E(A)	T	T	T

Dimensional:

	I(B)	B(B)	E(B)
I(A)	2	-1	-1
B(A)	1	-1	-1
E(A)	2	1	2

Figure3: A map of Italy and San Marino

(b) A: Italy, B: San Marino

Boolean:

	I(B)	B(B)	E(B)
I(A)	F	F	T
B(A)	F	T	T
E(A)	T	F	T

Dimensional:

	I(B)	B(B)	E(B)
I(A)	-1	-1	2
B(A)	-1	1	1
E(A)	2	-1	2

* Boundaries are exactly

Q5: Given the schema:

County (CountyName: varchar, CountyPop: integer, VehicleYear: float, Shape: Polygon)
Road (RoadName: varchar, RoadLength: float, RoadShape: LineString)
GasStation (StoreID: integer, StoreName: varchar, StoreShape: Point)
House (HouseNo: varchar, RoadName: varchar, CountyName: varhchar, HouseShape: Point**)**

where table names are bold (e.g., **County**), and the primary keys are underlined (e.g., CountyName), answer the following questions.

5a. For the City table, match the corresponding SQL queries and RA queries.

Reminder: The equivalence of following SQL statement in relational algebra as follows:

SELECT (symbol: σ)
PROJECT (symbol: π)
RENAME (symbol: ρ)

For example, conisder the following sql expression for student table :
Student (StudnetID: varchar, name: varchar, GPA: integer).

Select name from student where GPA>3.5, the equivalent relational algebra is: $\pi_{name}\left(\sigma_{gpa>3.5}(Stundet)\right)$

SQL Query	**RA query**
(1) SELECT Ci._CountyName FROM County Ci WHERE Ci.VehicleYear > 1995 AND Ci. CountyPop > 500,000 AND Ci. CountyPop < 850,000; d	a. $Ci1 = \pi_{CountyName}\left(\sigma_{CountyName\ LIKE\ 'F\%'}County\right)$ $Ci2 = \pi_{CountyName}\left(\sigma_{CountyPop\ >750,000}County\right)$ $Ci1 \cap Ci2$
(2) SELECT Ci. CountyName FROM County Ci1, County Ci2 WHERE Ci2. CountyPop < 750,000 AND Ci1. CountyName LIKE 'C%' AND Ci1.VehicleYear > Ci2.VehicleYear; c	b. $Ci1 = \pi_{CountyName}(County)$ $Ci2 = \pi_{CountyName}\left(\sigma_{\substack{VehicleYear < 2016 \\ \wedge\ CountyPop > 500,000}} County\right)$ $Ci1 - Ci2$
(3) SELECT Ci1.CountyName FROM County Ci1 WHERE Ci1.CountyName NOT LIKE ALL (SELECT Ci2.CountyName FROM County Ci2 WHERE Ci2.VehicleYear < 2016 AND Ci2.CountyPop > 500,000); b	c. $Ci1 =$ $\pi_{CountyName,CountyPop}\left(\sigma_{CountyName\ LIKE\ 'C\%'}County\right)$ $Ci2 = \pi_{CountyName,CountyPop}\left(\sigma_{CountyPop\ <750,000}County\right)$ $\pi_{Ci1.CountyName}\left(Ci1 \bowtie_{Ci1.VehicleYear\ >Ci2.VehicleYear}\right)$
(4) SELECT Ci1.StateName FROM County Ci1, County Ci2 WHERE Ci2.CountyPop > 750,000 AND Ci1.CountyName LIKE 'F%' AND Ci1.CountyName = Ci2.CountyName a	d. $\pi_{Name}\left(\sigma_{\substack{VehicleYear > 1995\ \wedge\ CountyPop > 500,000 \\ \wedge\ CountyPop < 850,000}} County\right)$

5b. Write SQL3/OGIS simple feature type expression for the following English questions.

(1) List the number of gas station in the Hennepin County. Briefly justify by giving your interpretation of the preposition 'in'.

SELECT count(GS.StoreID) as numGasStationsHennepin FROM GasStation GS, County Co
WHERE Within(GS.StoreShape,Co.Shape)=1
AND Co.CountyName='Hennepin';

Explanation: I understood this to mean the number of gas stations within Hennepin county.

(2) Give the name of the roads intersecting with "University Avenue".

```
SELECT DISTINCT Ro.RoadName FROM Road Ro, Road Ro1
WHERE Intersect(Ro.RoadShape, Ro1.RoadShape)=1
AND Ro.RoadName=’University Avenue’
AND Ro1.RoadName<>’University Avenue’
```

Explanation: I think this could have been interpreted as cross(Ro.RoadShape, Ro1.RoadShape)=1 as well. The distinct qualifier is also optional based strictly on the wording of the question.

(3) For each house list the nearest gas station, its distance and store the result of Query-3 in the temporary table: **House_temp** (HouseNo: varchar, RoadName: varchar, CountyName: varhchar, DistToGasStation: float).

```
SELECT Ho.HouseNo, Ho.RoadName, Ho.County Name, Distance(Ho.HouseShape,GS.StoreShape) as DistToGasStation
INTO House_temp
FROM House Ho, GasStation GS
WHERE Distance(Ho.HouseShape,GS.StoreShape) <= ALL (SELECT Distance(Ho.HouseShape,GS1.StoreShape)
                                                    FROM GasStation GS1
                                                    WHERE GS.StoreID<>GS1.StoreID)
```

Explanation: Chooses only the distance to the closest gas station from each house, along with all other columns of House_temp.