# HOMEWORK 1 - SOLUTION

## Part 1

1. Give 3 examples of transactions, other than an ATM bank withdrawal, in which a real-world event occurs if and only if the transaction commits.
   - Purchasing an airline ticket.
   - A student register for a class.
   - A room is reserved in an hotel.
   - Buying a book or a cd on Amazon.com
   - Open an account with a service provide (AOL...)
2. State 3 possible integrity constraints for the database in an airline reservation system.
   - A reservation concerns only one flight.
   - A seat is assigned to one customer.
   - A customer cannot reserve a plane ticket if the plane is full.
   - Customers do not have the same reservation number.
   - The weight of languages must not exceed the maximum allowed.
   - Minimum deposit of a certain amount of money.
3. The schema of the Student Registration System includes the number of current registrants and a list of registered students in each course.
   (a) What integrity constraint relates this data?
   nb of registrants = nb of registrants in the list
   (b) How might a registration transaction that is not atomic violates this constraint?
   A transaction is atomic if it runs to completion or, if it does not complete, it has no effect at all (as if it had never been started) (whatever changes the transaction has made are rolled back if the transaction is aborted).
   A not atomic transaction occurs and the number of registrants is $n$ but the nb of registrants in the list is not $n$. The database is inconsistent. If the transaction commits both action occur (number of students and addition to the list) and if it aborts neither occurs.
   Such a transaction may occurs if:
   - The transaction is involved in a deadlock and cannot obtain resources to continue execution.
   - There is a system crash.

- The user cancels the transacction...

(c) Suppose the system also implements a transaction that displays the current information about a course. Give a non-isolated schedule in which the transaction displays inconsistent information.

A non-isolated schedule is a schedule where transactions are executed concurrently and where the executions of the transactions leave the database in an inconsistent state.

Assume that there are 3 students in the class. The current list of students is Gene, Susan, Chris.

Transaction T1: add John to the class (using read and write).

Transaction T2: add Tom to the class (using read and write).

T1 reads the number of students (3) and the list of students (Gene, Susan, Chris).

T2 reads the number of students (3) and the list of students (Gene, Susan, Chris).

T1 adds John to the list (Gene, Susan, Chris, John). and update the number of students (4).

T2 adds Tom to the list (Gene, Susan, Chris, Tom). and update the number of students (4).

So the final state of the database is that there are 4 students in the database and they are: (Gene, Susan, Chris, Tom). John is not registered. The database is inconsistent, it does not reflect the real world.

Note: T1 and T2 are atomic.

4. Exercise 1.8 page 24 (or 1.8 page 20 depending of the version of your book)

   - **Physical level:** The array is saved at an address in memory (schema) and its contents is described by a sequence of bits (0 and 1) (instance)
   - **Conceptual level:** We use a programming language to describe an array.
     int[][] A = new int [2][4];
     The declaration $int[][]\ A$ is the schema of the array. The instances are the elements of the array. Here the elements of the array are 0.

| | | |
|---|---|---|
| 0 | 0 | 0 |
| 0 | 0 | 0 |

   - **View level:**
     We look at a line of the array or a column of the array. We look at a part of the array.

# Part 2

1. Let $S = \{\emptyset, a, b\}$ and $T = \{(1, 5), 2, 3\}$.

(a) What are $|S|$ and $|T|$ equal to? 3

(b) How many subsets does $T$ have? Why? $2^3 = 8$

(c) List all the subsets of $T$.
$\{\emptyset, \{(1,5)\}, \{2\}, \{3\}, \{(1,5),2)\}, \{(1,5),3)\}, \{2,3)\}, \{(1,5),2,3\}$

(d) Compute $S\ X\ T$?
$\{(\emptyset,(1,5)), (\emptyset,2), (\emptyset,3), (a,(1,5))(a,2), (a,3), (b,(1,5)), (b,2), (b,3)\}$

(e) Compute $T\ X\ S$?
$\{((1,5),\emptyset), (2,\emptyset), (3,\emptyset), ((1,5),a)(2,a), (3,a), ((1,5),b), (2,b), (3,b)\}$

(f) Is $A\ X\ B = B\ X\ A$ for all sets $A$ and $B$? Why?
No. We have a counter-example: $T\ X\ S$ is not equal to $S\ X\ T$.

(g) What are $|S\ X\ T|$ and $|T\ X\ T|$ equal to?
$|S\ X\ T| = 3 * 3 = 9$
$|T\ X\ T| = 3 * 3 = 9$

(h) Is $|A\ X\ B| = |B\ X\ A|$ for all sets $A$ and $B$? Why?
Yes because $|A\ X\ B| = |A| * |B| = |B| * |A| = |B\ X\ A|$ for all sets $A$ and $B$.

(i) Define a relation from $S$ to $T$ by a set.
A relation is a subset of $S\ X\ T$.
Let $R = \{(3,\emptyset), ((1,5),a)(2,a)\}$

(j) How many relation from $S$ to $S$ are there? Why?
A relation is a subset of $S\ X\ S$. There are $|S| * |S| = 3 * 3 = 9$ elements in $S\ X\ S|$ so there are $2^9$ relations from $S$ to $S$.

2. Consider the relation *Loan*.

   $Loan = \{(111, 900, 5/5/1972), (121, 600, 10/6/1980), (122, 500, 12/12/1990), (110, 200, 6/10/1992), (75, 1000, 9/9/2000)\}$

   Represent the relation *Loan* by a table.

| #loan | amount | date |
|---|---|---|
| 111 | 900 | 5/5/1972 |
| 121 | 600 | 10/6/1980 |
| 122 | 500 | 12/12/1990 |
| 110 | 200 | 6/10/1992 |
| 75 | 1000 | 9/9/2000) |

Note: A line in the table means: "The loan number $x$ is of amount $y$ and was made on the date $d$".