

# Databases 2020 — Assignment 2

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May 12th, 2020

**PLEASE READ THE GENERAL INSTRUCTIONS CAREFULLY BEFORE YOU START WITH YOUR SOLUTION. DUE TO THE LARGE SIZE OF THE CLASS, THE ADHERENCE TO THE INSTRUCTIONS IS INCREDIBLY IMPORTANT TO MAKE IT POSSIBLE FOR US TO CORRECT THE ASSIGNMENT SWIFTLY.**

Your submission should conform to the following rules:

## A TURNING IN YOUR WORK:

Please deliver your work for the assignment to `db2020-team@lists.liacs.nl`. Submit your assignment before or on **June 2nd, 19:00**. Start early with the completion of the Assignment, because late submissions will not be accepted. Please write your Student-IDs and names on each submitted page. Team size can either be 1 or 2. It is not allowed to copy solutions from other teams.

When you deliver your work past the given deadline, you will be penalized with  $-1,0$  point on your entire grade per week. The consequence for such a penalty holds from 1 minute late to 7 days late. If you are 7 days and 1 minute late, for example, you will receive a penalty of  $-2,0$  points.

## B SUBMISSION STRUCTURE:

Send a single .zip called `<studentno1>_<studentno2>_A2.zip`. For example, students s1403492 and s1639485 should hand in a .zip file called ***1403492\_1639485\_A2.zip***

The .zip's internal file structure should match that of figure 1. The files in the folders should match the names as mentioned in Figure 1.

- Your submission has to be fully digital **and written in L<sup>A</sup>T<sub>E</sub>X**. Hand-written answers will be penalized.
- The internal file structure of the .zip-file should match that of Figure 1
- Each group should make one submission via email.

## C ADDITIONAL TEXT:

Include clear explanations to answers where necessary.

**Failure to comply to any of these points will result in a penalty to your grade.**

A short reference chart for common L<sup>A</sup>T<sub>E</sub>X functions is given at the end of this assignment.

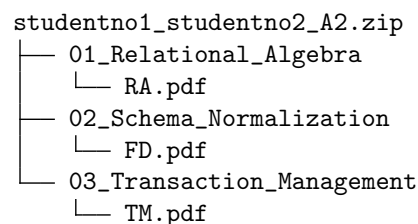


Figure 1: **The file structure your submission should match.**

1. **PLAGIARISM:**

Because Assignment 2 is part of your Final Grade, it is **strictly prohibited to copy any part of the work of other students**. Violation of this rule will be considered as **plagiarism** and will be sanctioned by **the Board of Examiners (de Examencommissie)**.

2. **RECOMMENDATIONS:**

Please start early with the Assignment and use the **practicals and lecture breaks to ask questions**, if possible, in order to avoid excessive emails.

3. **UPDATES:**

All updates concerning the Assignment will be published on Blackboard in the Announcement Section.

# 1 Relational Algebra

The local shopkeeper, Manus, sells weapons and keeps track of those he sold to the wandering knights visiting his establishment. King Vickers combines this data with a table of princesses, resulting in the following database:

Knights(kid:integer, name:string, age:int, overlord:string)

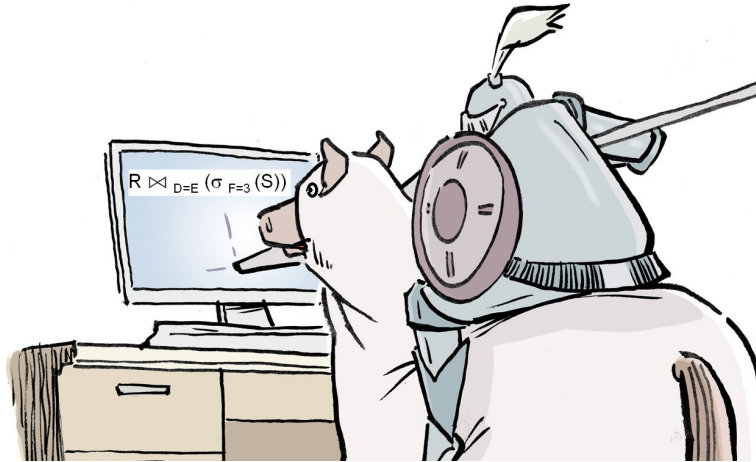
Princesses(pid:integer, name:string, age:int, overlord:string)

Weapons(wid:integer, name:string, price:real)

Purchases(kid:integer, wid:integer, timestamp:date, discount:bool)

Can you help King Vickers to answer the following questions? It might, otherwise, not end well for the shopkeeper. Hint: take a good look at the practical slides on Blackboard: these will help you save Manus!

1. Find the **name** and **kid** of all knights who have purchased a weapon.
2. Find the **names** of all knights who are named John Fist or are older than 30.
3. Find the **names** of all knights who have bought a weapon that has a listed price of more than 200 gold pieces.
4. Find the **names** of all knights who have purchased more than one weapon and have Lord Schrapnel as overlord.
5. Find the **names** of all knights who are older than John Fist.
6. Find the **names** of all knights who have only bought discounted weapons and, in addition, have the same age and overlord as one of the princesses.
7. Find the **names** of all knights who have purchased the most expensive weapon.



M.E., based on cartoon by John Klossner (2019)

## 2 Schema Normalization

1. **R1(A, B, C, D)**

FDs:  $AB \rightarrow C$ ,  $AB \rightarrow D$ ,  $C \rightarrow A$ , and  $D \rightarrow B$

2. **Edited version: R2(A, B, C, D, E)**

FDs:  $A \rightarrow BD$ ,  $B \rightarrow D$ ,  $AB \rightarrow C$ , and  $E \rightarrow A$

For the 2 given relations R1 and R2 and their corresponding FDs, do the following:

- (a) Identify the candidate key(s) for R1 & R2 and explain briefly why they are candidate key(s).
- (b) Derive a minimal cover for R1 and for R2 with their corresponding sets of functional dependencies.
- (c) Identify whether the relations satisfy BCNF and whether they satisfy 3NF. Explain briefly why (or why not).
- (d) If a relation is not in BCNF, derive a lossless join decomposition into BCNF and explain whether they preserve the dependencies (if they do not, indicate which FDs are not preserved).

### 3 Transaction Management

T1:	W(A)			W(C)		R(A)	Cmt.
T2:	R(A)		R(B)	W(B)	R(C)		Cmt.
T3:	W(C)		W(A)	R(C)		R(B)	Cmt.
T4:	R(C)	R(A)	W(B)				Cmt.

Figure 2: Interleaved schedule of transactions.

Complete the following tasks:

1. Depict the precedence graph for the interleaved schedule in Figure 2.
2. What feature of the graph indicates whether or not a schedule is conflict serializable and how are conflict serializability and serializability related in terms of implication? Is the given schedule conflict serializable and/or serializable?
3. Apply strict 2PL to the schedule and denote the resulting schedule until all transactions are terminated or a deadlock state is reached.
4. Draw the waits-for-graph for the schedule right after the first deadlock occurs.

## A L<sup>A</sup>T<sub>E</sub>X Reference

It is recommended to briefly browse the simple introduction to L<sup>A</sup>T<sub>E</sub>X in the wikibook, specifically the Mathematics section thereof: <https://en.wikibooks.org/wiki/LaTeX/Mathematics>

For our purposes, we will need the *amsmath* package:

```
\usepackage{amsmath}
```

We put an inline math formula between \$. For example, `$x^2+2x=3$` will become  $x^2 + 2x = 3$ . If we want to give the math formula more space we put it between double \$. For example `$$f(x)=\delta_0-x^i$$` Will become

$$f(x) = \delta_0 - x^i$$

For Schema Normalization it will probably be enough to know the  `$\rightarrow$` . In this way we can make simple derivations of functional dependencies, like this:

```
\begin{align*}
A &\rightarrow B \\
B &\rightarrow C \\
A &\rightarrow C \quad \text{(Transitivity)}
\end{align*}
```

$$\begin{aligned} A &\rightarrow B \\ B &\rightarrow C \\ A &\rightarrow C \text{ (Transitivity)} \end{aligned}$$

The align environment is very useful for multi-lined mathematics, such as what you might be doing with schema normalization.

For Relational Algebra a simple answer to a query might look like this:

```
\pi_{\text{name}} \sigma_{\text{age} > 18} \text{Students}
```

$$\pi_{\text{name}} \sigma_{\text{age} > 18} \text{Students}$$

Here the underscore ( `_` ) denotes the use of sub-script. Also, note the use of `\text{ }` for words. This command is from the *amsmath* package. If we didn't use it, L<sup>A</sup>T<sub>E</sub>X would interpret all written characters as mathematical variables and not typeset them correctly.

Other commands that might be of use for you while writing your Relational Algebra queries:

<code>A \bowtie B</code>	$A \bowtie B$
<code>A \times B</code>	$A \times B$
<code>(\text{age}&gt;18 \vee \text{age} &lt; 65) \wedge \text{name}=\text{"Hans"}</code>	$(\text{age} > 18 \vee \text{age} < 65) \wedge \text{name} = \text{"Hans"}$
<code>\pi\ \sigma\ \rho</code>	$\pi\ \sigma\ \rho$
<code>S\bowtie_{\text{sid}}R</code>	$S \bowtie_{\text{sid}} R$
<code>\begin{align*} \rho(X_1, \pi_{\text{name}}S) \ \\ X_1 \bowtie R \end{align*}</code>	$\begin{array}{c} \rho(X_1, \pi_{\text{name}}S) \\ X_1 \bowtie R \end{array}$
<code>A \setminus B, A / B</code>	$A \setminus B, A/B$

For Transaction Management we recommend using the tabular environment as described here: <https://en.wikibooks.org/wiki/LaTeX/Tables>