

## Practical Assignment of Advanced Topics in Databases (2022-23)

The practical assignment involves several of the topics seen so far, namely:

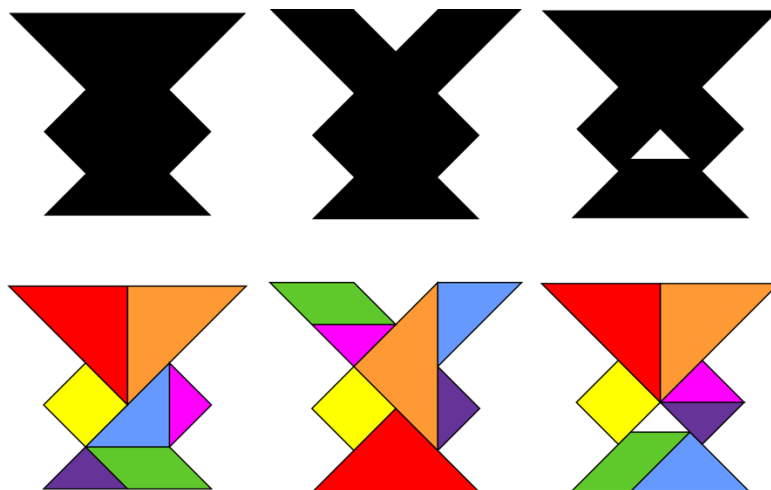
- APIs to database management systems;
- Deductive databases and the coupling of MySQL or Postgres and Yap;
- Spatial databases, spatial types and spatial functions;
- Visualizations involving Python and Matplotlib.

The subject of the practical assignment are **tangram puzzles**. The tangram is a dissection puzzle consisting of seven flat polygons, called *tans*, which are put together to form shapes. The objective is to replicate a pattern (given only an outline) generally found in a puzzle book using all seven pieces without overlap. It is one of the most widely recognized dissection puzzles in the world and has been used for various purposes including amusement, art, and education.

The 7 pieces of the tangram are:

- 2 large right triangles (hypotenuse 1, sides  $\sqrt{2}/2$ , area  $1/4$ )
- 1 medium right triangle (hypotenuse  $\sqrt{2}/2$ , sides  $1/2$ , area  $1/8$ )
- 2 small right triangles (hypotenuse  $1/2$ , sides  $\sqrt{2}/4$ , area  $1/16$ )
- 1 square (sides  $\sqrt{2}/4$ , area  $1/8$ )
- 1 parallelogram (sides of  $1/2$  and  $\sqrt{2}/4$ , height of  $1/4$ , area  $1/8$ )

The figure below displays three puzzles to be solved (in black) and the respective solutions using the 7 pieces of the tangram.



### 1. Part 1 of the practical assignment

The first part of the project involves creating a database with three tables either in MySQL or Postgres using spatial types:

- A table to represent the seven pieces, with an additional attribute that assigns a color to a piece, as in the picture above;
- A table to represent puzzles;
- A table to represent solutions of each puzzle of the previous table.

Note that we have studied spatial extensions using Postgres, but in MySQL it is very similar. However, MySQL spatial extensions have more limitations than the implementation of Postgres.

This part accounts for 30% of the total grade of the practical assignment. The correct creation of the tables and the correct spatial representations of the spatial objects is the main criteria used in the evaluation. Minor points are assigned to the number and originality of the puzzles represented.

## **2. Part 2 of the practical assignment**

The second part of the practical assignment involves connecting Yap to either MySQL or Postgres. Note that we have seen the MySQL C API, but Postgres also has a similar API (the libpq C library). The goal is to connect to the three tables create in Part 1 and design a representation as Yap terms of the data in those tables, including spatial data.

You should also create some logic predicates that can help with the resolution of puzzles. Such predicates include the following:

- `st_difference`
- `st_translate`
- `st_rotate`

Note that `st_difference` exists both in Postgres and MySQL, but `st_translates` and `st_rotate` are only available in Postgres (Postgis). Its implementation in Prolog, however, is very simple. You should decide if want to have an additional effort in studying the libpq and make use of more functions from Postgis, or use the MySQL C API and have additional effort in implementing `st_translate` and `st_rotate`.

This part accounts for 40% of the practical assignment and the main criteria used for evaluation is the correct logic term representation of the data fetched from the three tables of part 1. Which spatial predicates are implemented and how they are implemented is also relevant. Note that it is not relevant to implement predicates that would not be useful to help solve the puzzles.

## **3. Part 3 of the practical assignment**

Part 3 involves only the Python interface either to MySQL or Postgres and the use of Matplotlib to visually represent the puzzles and solutions tables, in a similar way to the figure displayed above. This part accounts for 15% of the grade.

## **4. Part 4 of the practical assignment**

Part 4 is a valuation part and involves trying to solve the puzzle using the backtracking mechanism of Prolog and the predicates created. The solving principle should be to try to place a piece from the pieces table in the puzzle to be solved. This placement involves using predicates `st_translate` and `st_rotation` over the pieces. Once the piece is place in

the puzzle, `st_difference` computes the difference and derives a new puzzle. The process continues using the remaining pieces and the new puzzle. It is solved when all pieces are used. This part accounts for the remaining 15% of the grade.

## **5. Groups and dates**

This practical assignment is to be done in groups of 2 or 3 students. Groups shall be created in Moodle. There will be a presentation of the practical assignment that also counts for the final grade of each student, as was previously defined.

The following dates are defined:

- a. Submit an archive through Moodle with all the files, including a small report (up to 4 pages) until 23:59:59 May 25<sup>th</sup> 2023;
- b. Presentations will be done on Friday, May 26<sup>th</sup> in time slots to be defined to each group.

Good luck!