

Exercise 1

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The exercise is based on the *Mondial* database. Its schema can be accessed at <https://files.ifi.uzh.ch/dbtg/dbs/mondial/schema.pdf>

Relational Algebra

Formulate relational algebra expressions that answer the following queries for the *Mondial* relational schema. **No aggregation** is allowed in this exercise. Make sure your expressions are correct for all database instances with the *Mondial* schema, i.e., do not use any constants other than the ones provided in the descriptions.

The relevant relations for answering the following queries are **borders**, **country**, **geoRiver**, **geoSea**, **island**, and **province**.

1. The names of all islands that are volcanic or coral. You may use the constants 'volcanic' and 'coral'.
2. The names of all rivers that flow through at least two different provinces of the same country.
3. The name(s) of the Swiss province(s) with the highest ratio of inhabitants per area. You may only use the country code 'CH'.
4. The codes of all countries that are adjacent to either the Pacific ocean or the Atlantic ocean (but not to both). You may use the names of the oceans in your expression.
5. The names and codes of all countries that have a border length of more than 100km with at least one neighboring country.

How often is the code of a country contained in the result if the country has a border length of more than 100km with 3 neighboring countries? Explain.

6. State precisely in natural language what the following relational algebra expression computes.

$$\pi_{\text{Name}}(\pi_{\text{Name,Code}}(\mathbf{country}) - \pi_{\text{Name,Code}}(\sigma_{\text{Length} < 100}(\mathbf{borders} \bowtie_{\text{Code}=\text{Country1} \vee \text{Code}=\text{Country2}} \mathbf{country})))$$

There exist database instances on which the above relational algebra expression and a modified expression that does not contain the country code in the two projections when calculating the difference evaluate to different results. Explain and give an example.