

## Declarative Programming

Workshop exercises set 6.

### QUESTION 1

Download the files `borders.pl`, `cities.pl`, `countries.pl`, and `rivers.pl`. These files contain facts about the world circa 1980. Create a file `world.pl` and insert the four lines:

```
:- ensure_loaded(borders).  
:- ensure_loaded(cities).  
:- ensure_loaded(countries).  
:- ensure_loaded(rivers).
```

These lines will automatically load the four files when you load your `world.pl` file.

Start up SWI Prolog and load your `world.pl` file.

This will define a predicate `borders/2` (that notation means a predicate named `borders` that takes two arguments) describing which countries and oceans border which others.

Give a query to find what borders Australia (remember: Prolog symbols are all lower case).

### QUESTION 2

Give a query to find what shares a border with both France and Spain.

### QUESTION 3

The files you have loaded also define a predicate `country/8`:

```
country(Country,Region,Latitude,Longitude,Area,  
        Population,Capital,Currency)
```

where `Country` is a country located in `Region` at the indicated `Latitude` and `Longitude`, occupying the specified `Area`, occupied by the specified `Population`, with the specified `Capital` city and using the specified `Currency`.

Give a query to find what countries share a border with both France and Spain. Remember, `_` specifies a "don't care" variable.

### QUESTION 4

Edit your `world.pl` file and define a predicate `country/1` so that `country(C)` holds when `C` is any country. Reload your file and use your new `country/1` predicate to find what countries share a border with both France and Spain. Note that you can type the goal "make." to Prolog to reload any changed files, much like `":reload` (or `":r`") in GHCi.

### QUESTION 5

Edit your `world.pl` file again to define a predicate `larger/2` so that `larger(Country1, Country2)` holds when the area of `Country1` is larger than that of `Country2`. You can use the (infix) predicates `<` and `>` to compare numbers, but note that you must ensure that the arguments of a comparison are bound when the comparison is executed, so the goals that bind the values to be compared must appear before the comparison.

Which is bigger, Australia or China?

## QUESTION 6

The predicate `river/2` relates rivers, their countries, and the sea they drain into. `river(River, Countries)` holds when `River` is a river that flows through or into all of the countries on the list `Countries`.

The `member/2` predicate is an SWI Prolog built-in that relates lists and their elements. `member(Elt, Lst)` holds when `Elt` is an element of `Lst`.

Write a predicate `river_country(River, Country)` that holds when `River` is a river, `Country` is a country, and `River` flows into and/or out of `Country`.

Also write a predicate `country_region(Country, Region)` that holds when `Country` is a country in region `Region`.

Give a query to find a river that flows between countries in different regions.