Introduction to database systems 2021/2022

Homework 1

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Consider the following relational database (primary keys are underlined, while foreign keys are symbolised by a hash-tag (#)):

city (id, name, countrycode, district, population)
country (code, name, continent, region, surfacearea, indepyear, population, lifeexpectancy, gnp, gnpgold, localname, governmentform, headofstate, #capital, code2)
countrylanguage (countrycode, #language, isofficial, percentage)

All relations are a part of the schema world (Postgresql server). More information, including attribute description, can be found on the following url:
https://dataedo.com/samples/html/World_MySQL/doc/World_(MySQL_database)_9/modules/World_database_diagram_104/tables.html

Part 1 (50 %): Generate SQL queries to answer the following questions:

(6 %) a) Find all information about countries of the continent Europe.

SELECT *
FROM country
WHERE continent = 'Europe'

(6 %) b) Find names of all countries whose population is greater than 10 millions (10000000) and life expectancy is less than 70 years old.

SELECT name
FROM country
WHERE Population > 10000000 AND LifeExpectancy < 70

(6 %) c) Find names of all cities whose name begins with the letter "R", and their name do not contain any letters "o".

SELECT name
FROM country
WHERE name LIKE 'R%'
AND
NAME NOT LIKE'%o%'

(7 %) d) Find countries that share the same name as their capital city.

SELECT country.name
FROM country,city
WHERE city.id = capital AND city.name = country.name

(8 %) e) Find name of countries where are spoken at least 10 and at most 15 languages, either official or unofficial. List should be ordered in ascending order .

SELECT c.name, COUNT(cl.language)
FROM country c, countrylanguage cl
WHERE c.code = cl.countrycode
GROUP BY c.name
HAVING COUNT (cl.language) > 10 AND COUNT (cl.language) < 15
ORDER BY c.name ASC

(8 %) f) Find all Asian cities whose population is greater than population of every single Nordic country (attribute region).

SELECT ci.name

FROM city ci, country co

WHERE co.continent = 'Asia' AND ci.countrycode = co.code AND

ci.population > ALL (SELECT population

        FROM country c2

        WHERE c2.region = 'Nordic Countries')

(9 %) g) Return the number of countries that have an official language that is not present in any other countries in the world.

SELECT COUNT(*) as "Number of Countries"

FROM countrylanguage cl1

WHERE isOfficial = 'T' AND language <> ALL (

        SELECT cl2.language

        FROM countrylanguage cl2

        WHERE cl1.countrycode <> cl2.countrycode)

Part 2 (50 %): Give an expression in RELATIONAL ALGEBRA and RELATIONAL CALCULUS to express each of the following queries: country co, city ci, countrylanguage cl

(8 %) a) Find names of all countries with gross national product (GNP) greater than 10000 and its capital city with the population of more than 1 million.

$$\pi_{name}\left(\sigma_{gnp>10000} \wedge \sigma_{capital=\sigma_{id}} \wedge \sigma_{population>1000000}(co \bowtie ci)\right)$$

$\{<co> | <cod,nam,con,rg,gp,lf,gyp,loc,cap> \in country \wedge \exists <id,na,cc,di,po> \in city (gnp>10000 \wedge cap=id \wedge pop>1000000)\}$

(8 %) b) Find names of countries that do not have any unofficial languages.

$$\pi_{name}(\sigma_{code=\sigma_{countrycode}}) - \pi_{name}(\sigma_{code=\sigma_{countrycode}} \wedge \sigma_{isOfficial='FALSE'}(co \bowtie cl))$$

$\{<co> | <cod,nam,con,rg,gp,lf,gyp,loc,cap> \in country \wedge \exists <cc2,la,is,pe> \in countrylanguage (cod=cc2) \wedge \neg \exists <cc2,la,is,pe> \in countrylanguage (is='false')\}$ (negation)

(8 %) c) Find names of countries, that have Spanish as the only official language.

$$\pi_{name}(\sigma_{code=\sigma_{countrycode}} \wedge \sigma_{isOfficial='TRUE'}(co \bowtie cl)) - \pi_{name}(\sigma_{code=\sigma_{countrycode}} \wedge \sigma_{language \neq 'Spanish'} \wedge \sigma_{isOfficial='TRUE'}(co \bowtie cl))$$

$\{<co> | <cod,nam,con,rg,gp,lf,gyp,loc,cap> \in country \wedge \exists <cc2,la,is,pe> \in countrylanguage (cod=cc2 \wedge is=True) \wedge \neg \exists <cc2,la,is,pe> \in countrylanguage (cod=cc2 \wedge is=True \wedge la \neq 'Spanish')\}$

(8 %) d) Find European countries that have a population greater than any Asian country.

Asian country renaming $\Rightarrow \rho(asia), \sigma_{continent='Asia'}(c)$

$$\pi_{name}(\sigma_{continent='Europe'} \wedge \sigma_{population>}(\sigma_{asia.population})(c))$$

$\{<co> | <cod,nam,con,rg,gp,lf,gyp,loc,cap> \in country \wedge \exists <cod2,nam2,con2,rg2,pp2,lf2,gyp2,loc2,cap2> \in country (con='Europe' \wedge con2='Asia' \wedge pop>pop2)\}$

(8 %) e) Find countries that share the same name as their capital city.

$$\pi_{co.name}(\sigma_{co.capital=ci.id} \wedge \sigma_{co.name=ci.name}(ci \bowtie co))$$

$\{<co> | <cod,nam,con,rg,gp,lf,gyp,loc,cap> \in country \wedge \exists <id,na,cc,di,po> \in city (cap=id \wedge nam=na)\}$

(10 %) f) Find countries that have a population greater than every Spanish speaking country in the world (Spanish as official or unofficial language)

Spanish speaking country renaming $\Rightarrow \rho(spa), (\sigma_{language='Spanish'} \wedge \sigma_{code=\sigma_{countrycode}}(co \bowtie cl))$

$$\pi_{name}(\sigma_{population>spa.population} \wedge \sigma_{code=countrycode}(co \bowtie cl))$$

$\{<co> | <cod,nam,con,rg,gp,lf,gyp,loc,cap> \in country \wedge \forall <cod2,nam2,con2,rg2,pp2,lf2,gyp2,loc2,cap2> \in country (pop>pop2) \wedge \forall <cc2,la,is,pe> \in countrylanguage (cod2=cc2 \wedge la='Spanish')\}$