TD 02 – Logical aspect of databases

Evaluation. This week, exercises 2, 3, 4 and 7 are due. Your answers must be submitted on the Moodle `moodle.di.ens.fr`, before 23:59 on Sunday, February 18th, by uploading a PDF file containing your answers. Readable scans will be accepted, but the use of LaTeX is **highly recommended**.

Consider the following schema:

- Cinema(Name, Time, Title)

- Movie(Title, Director, Actor)

- Produced(Producer, Title)

- Seen(Viewer, Title)

- Likes(Viewer, Title)

Exercise 1. Discuss changes one might want to make to this schema.

1 Conjunctive queries

Exercise 2. Whenever possible, express the following queries in PSJR algebra and conjunctive calculus.

1. Where and when can one see the movie "Mad Max"?

2. What are the titles of the movies directed by Orson Welles?

3. Who are the actors playing in "Ran"?

4. Where can one see a movie in which Signoret plays?

5. Who are the actors that produced a movie?

6. Who are the actors that produced a movie in which they play?

7. Which actors play in a movie Orson Welles plays in?

8. Which producers produce all the movies directed by Akira Kurosawa ?

2 Beyond conjunctive queries

Exercise 3. If possible, express the following queries in PSJRU algebra with complement and in relational calculus.

1. Which viewers watch all the movies?

2. Which viewers like all the movies they watch?

3. Who produces a movie that does not play in any cinema?

4. Which producers see all the movies they produce?

5. Which actors have a Bacon number? Bacon number is the Erdős number for Kevin Bacon in Cinema: Kevin Bacon has a Bacon number of 0, and anyone having played with someone with Bacon number n has Bacon number $n + 1$ (if not already smaller).

3 Syntactic sugar

Consider I over X and J over $Y \subset X$, and let us define division $I \div J$ over $X - Y$ as:

$$\{x \mid \forall y \in J, [x, y] \in I\}.$$

Exercise 4. Show that division is a redundant operator, *i.e.* that it can be expressed using the other operators of PSJRU algebra with complement.

Consider I over X, J over Y and $Z = X \cap Y$, and define the join complement $\bar{\bowtie}$ over X as:

$$\{x \in I \mid \pi_Z(x) \notin \pi_Z(J)\}.$$

Exercise 5. Show that join complement is a redundant operator.

4 Conversions

Consider two relations: R with attributes A, B and S with attributes B, C.

Exercise 6. Give an equivalent relational algebra expression for each of the following relational calculus expressions.

1. $\{x \mid \exists y\ R(y, x) \land \neg \exists z\ S(x, z)\}$.

2. $\{x \mid \exists y\ R(x, y) \land \forall y\ \neg S(y, x)\}$.

3. $\{x \mid \big(\exists y\ R(y, x) \land \neg \exists z\ S(x, z)\big) \land \big(\exists u\ R(x, u) \land \forall v\ \neg S(v, x)\big)\}$.

Exercise 7. Give an equivalent relational calculus expression and an equivalent relational algebra expression for each of the following SQL queries.

1. **SELECT** R.A
   FROM R
   WHERE NOT EXISTS (**SELECT** $*$ **FROM** S **WHERE** S.C=R.A) **AND** R.B > 1

2. **SELECT MAX**(A) **FROM** R