Find the drinkers who frequent **only** bars serving a beer they like

$\forall x \in R\ \varphi(x) \equiv \neg\exists x \in R\ \neg\varphi(x)$

$$\{d: drinker \mid \exists f \in frequents\ (f(drinker) = d(drinker) \wedge \\ \forall y \in frequents[y(drinker) = f(drinker) \rightarrow \\ \exists s \in serves \exists l \in likes(s(bar) = y(bar) \wedge \\ s(beer) = l(beer) \wedge l(drinker) = y(drinker))]\}$$

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```
select f.drinker
from frequents f
where not exists
        (select *
        from frequents y
        where y.drinker = f.drinker and not exists
                (select *
                from serves s, likes l
                where s.bar= y.bar
                and s.beer= l.beer
                and l.drinker = y.drinker))
```

```
select drinker
from frequents  where drinker not in
        (select f.drinker
        from frequents f
        where f.bar not in
                (select bar
                from serves, likes
                where serves.beer = likes.beer
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```

List the days when no red boat is reserved

$$\{d: day \mid weekday(d) \wedge \forall r \in reservation\ \forall b \in boat \\ ((r(day) = d(day) \wedge r(bname) = b(bname)) \rightarrow b(color) \neq red)\}$$

$$\{d: day \mid weekday(d) \wedge \neg\exists r \in reservation\ \exists b \in boat \\ (r(day) = d(day) \wedge r(bname) = b(bname) \wedge b(color) = red)\}$$

```
select d.day from weekday d
where not exists
        (select * from reservation r, boat b
        where r.day = d.day and r.name = b.bname AND b.color= 'red')
```

Find actors playing in every movie by Berto

$$\{a\text{: actor} \mid \exists y \in \text{movie}\ [a(\text{actor}) = y(\text{actor}) \wedge \\ \forall m \in \text{movie}\ [m(\text{director}) = \text{“Berto”} \rightarrow \exists t \in \text{movie}\ (m(\text{title}) = \\ t(\text{title}) \wedge t(\text{actor}) = y(\text{actor}))]]\}$$

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```
CREATE VIEW berto-movie AS
SELECT title FROM movie WHERE director = 'bertolucci'

CREATE VIEW not-all-berto AS
SELECT m.actor FROM movies m, berto-movies
WHERE berto-movies.title NOT IN
      (SELECT title FROM movies
       WHERE actor = m.actor)

SELECT actor FROM movies WHERE actor NOT IN
      (SELECT * FROM not-all-berto)
```

List the directors that every actor is cast in one of his movies

$$\{d: director \mid \ \exists m \in movie\ [d(director) = m(director)\ \wedge \\ \forall a \in movie\ \exists x \in movie\ \exists y \in movie(x(director) = m(director) \wedge x(title) = y(title) \\ \wedge\ y(actor) = a(actor))]\}$$

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Propositional logic

- $\neg(\neg p) = p$
- $p \rightarrow q = \neg p \vee q$ (definition of implication)
- $\neg(p \wedge q) = \neg p \vee \neg q$ (De Morgan's Law 1)
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Below R is a relation and Q, Q_1, Q_2 are calculus formulas.

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- $\forall x \in R\ (Q_1(x) \wedge Q_2(x)) = \forall x \in R\ (Q_1(x)) \wedge \forall x \in R\ (Q_2(x))$ ($\forall$ distributes over $\wedge$)

Note that $\exists$ does not distribute over $\wedge$ and $\forall$ does not distribute over $\vee$ (think of some counter-examples!). However, suppose x occurs in Q_1 but not in Q_2. Then:

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- $\forall x \in R\ (Q_1(x) \vee Q_2) = \forall x \in R\ (Q_1(x)) \vee Q_2$

Also note the following useful facts that follow from the previous ones:

- $\forall x \in R\ (Q_1(x) \rightarrow Q_2(x)) = \neg(\exists x \in R\ (Q_1(x) \wedge \neg Q_2(x)))$
- $\forall x \in R\ \forall y \in R\ (Q(x, y)) = \neg(\exists x \in R\ \exists y \in R\ (\neg Q(x, y)))$

If Q_2 does not contain x then:

- $[\exists x \in R\ (Q_1(x)) \rightarrow Q_2] = \forall x \in R\ [Q_1(x) \rightarrow Q_2]$

Basic

- Testing if an attribute A is null: **IS null, IS NOT null**
- Arithmetic operations: involves any null return null
- Comparison: involves any null return ***unknown***

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update views without aggregates, nesting, group-by or tuple alias, defined on a **single table**

N/A	pro	con
virtual	no need to maintain correspondence with base	inefficient for views defined via **complex** queries
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Find the drinkers who frequent **only** bars serving a beer they like

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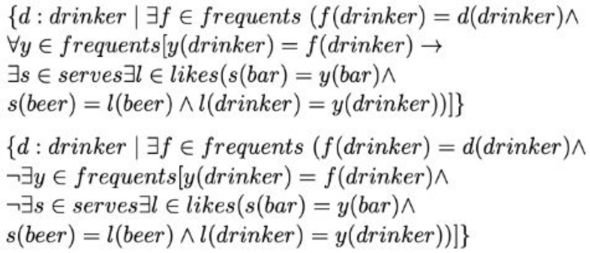

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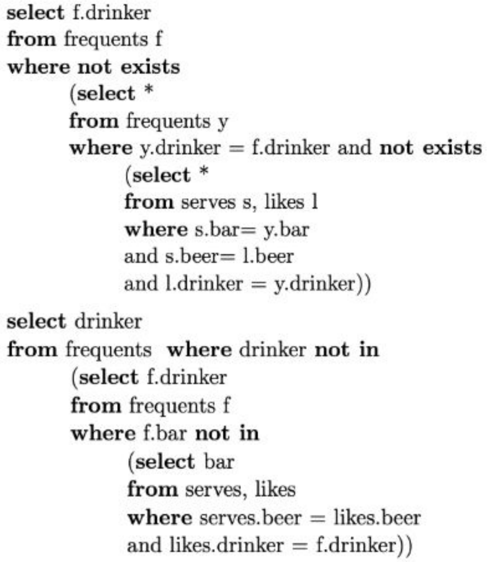

```
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```

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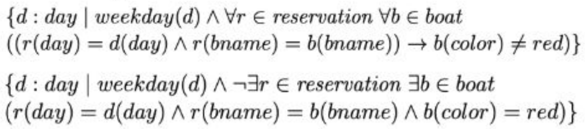

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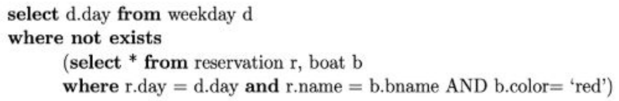

```
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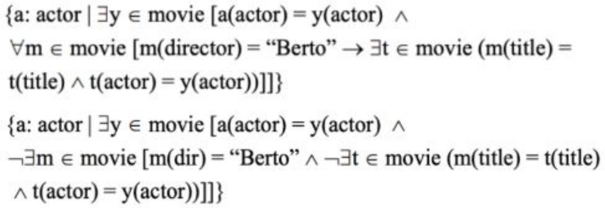
Find actors playing in every movie by Berto



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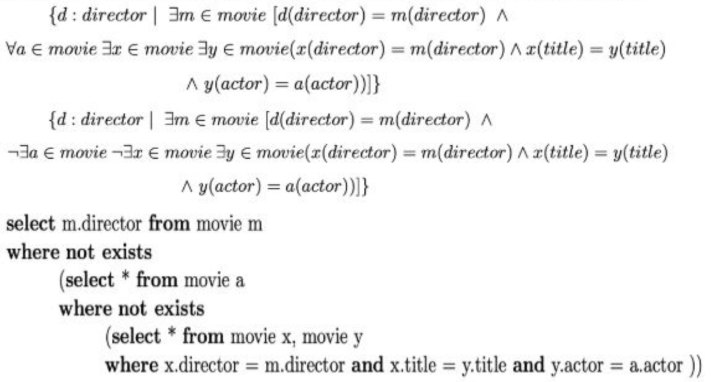

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```
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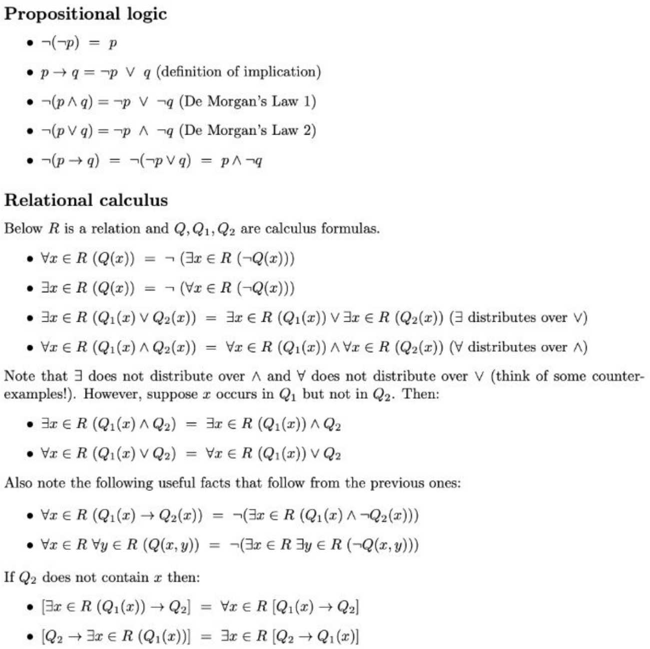

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