

Homework 1

assigned September 18; due October 2, 5pm

This is a pencil-paper assignment. If you wish, you can work in groups of two people (but submit only *one* assignment per group). When you submit the assignment, don't forget to indicate the section you are in.

Assignments are to be submitted to the course drop box, located in Bahen 2220.

Your name(s) and student number(s) should appear on the first page of the assignment. Pages must be numbered, and assignments must be stapled or – preferably – stapled *and* put in envelopes. If pages are missing, you won't be given any credit. For late assignment policies, consult the course webpage.

Consider the following relational schema describing concert halls, cities where they are located, and shows.

- City(name, province, country)
- Hall(name, city, province, capacity) (here city refers to the name attribute of City, province refers to the province attribute of City)
- Show(title, artist, hall, attendance) (here hall refers to the name attribute of Hall)

Write the following 8 queries in both Relational Algebra and SQL. In relational algebra, you are **not** allowed to use the linear notation and renaming of *relations* used in the text. You may use renaming of attributes. You may use numerical comparisons (e.g., $R.A > 5$) in both SQL and Relational Algebra.

Each question is worth 15 points (7 for SQL, 8 for Relational Algebra).

(1) List names of concert halls in Toronto whose capacity exceeds 10,000.

```
SELECT name
FROM Hall
WHERE city = 'Toronto'
AND capacity > 10000
```

$$\pi_{name}(\sigma_{(capacity > 10000) \wedge (city = 'Toronto')}(Hall))$$

(2) List names of artists who performed before at least 10,000 spectators, together with cities where those performances took place.

```
SELECT S.artist, H.city
FROM Show S, Hall H
WHERE S.hall = H.name
AND S.attendance >= 10000
```

$$\pi_{artist, city}(\sigma_{attendance \geq 10000}((\rho_{name \leftarrow hall} Show) \bowtie Hall))$$

(3) Find all the provinces in Canada where Springsteen has performed.

```
SELECT C.province
FROM Show S, Hall H, City C
WHERE S.hall = H.name
AND H.city = C.name
AND H.province = C.province
AND C.country = 'Canada'
AND S.artist = 'Springsteen'
```

$$\pi_{\text{province}}(\sigma_{(\text{country}='Canada') \wedge (\text{artist}='Springsteen')}((\rho_{\text{name} \leftarrow \text{hall}} \text{Show}) \bowtie \text{Hall} \bowtie (\rho_{\text{city} \leftarrow \text{name}} \text{City}))))$$

(4) Find all artists who performed at least three times in Ontario.

Assuming <title,hall> pair is a unique show identifier

```
SELECT S1.artist
FROM Show S1, Show S2, Show S3, Hall H1, Hall H2, Hall H3
WHERE S1.artist = S2.artist
AND S2.artist = S3.artist
AND S1.hall = H1.name
AND S2.hall = H2.name
AND S3.hall = H3.name
AND H1.province = 'Ontario'
AND H2.province = 'Ontario'
AND H3.province = 'Ontario'
AND (S1.title <> S2.title OR S1.hall <> S2.hall)
AND (S2.title <> S3.title OR S2.hall <> S3.hall)
AND (S1.title <> S3.title OR S1.hall <> S3.hall)
```

$$\pi_{\text{artist}}(\sigma_{((\text{title2} <> \text{title3}) \vee (\text{hall2} <> \text{hall3})) \wedge ((\text{title1} <> \text{title2}) \vee (\text{hall1} <> \text{hall2})) \wedge ((\text{title1} <> \text{title3}) \vee (\text{hall1} <> \text{hall3}))}(\rho_{\text{title1} \leftarrow \text{title}, \text{hall1} \leftarrow \text{hall}}(\pi_{\text{artist}, \text{title}, \text{hall}}(\text{Show} \bowtie (\rho_{\text{hall} \leftarrow \text{name}} \text{Hall}) \bowtie (\sigma_{(\text{province}='Ontario') \wedge (\text{country}='Canada')}(\rho_{\text{city} \leftarrow \text{name}} \text{City})))))) \bowtie (\rho_{\text{title2} \leftarrow \text{title}, \text{hall2} \leftarrow \text{hall}}(\pi_{\text{artist}, \text{title}, \text{hall}}(\text{Show} \bowtie (\rho_{\text{hall} \leftarrow \text{name}} \text{Hall}) \bowtie (\sigma_{(\text{province}='Ontario') \wedge (\text{country}='Canada')}(\rho_{\text{city} \leftarrow \text{name}} \text{City})))))) \bowtie (\rho_{\text{title3} \leftarrow \text{title}, \text{hall3} \leftarrow \text{hall}}(\pi_{\text{artist}, \text{title}, \text{hall}}(\text{Show} \bowtie (\rho_{\text{hall} \leftarrow \text{name}} \text{Hall}) \bowtie (\sigma_{(\text{province}='Ontario') \wedge (\text{country}='Canada')}(\rho_{\text{city} \leftarrow \text{name}} \text{City})))))))))$$

(5) List all cities where Toronto symphony (value of the title attribute) under direction of Zukerman (value of the artist attribute) had a sold out concert.

```
SELECT H.city
FROM Show S, Hall H
WHERE S.hall = H.name
AND S.attendance = H.capacity
AND S.artist = 'Zukerman'
AND S.title = 'Toronto symphony'
```

$$\pi_{\text{city}}(\sigma_{\text{title}='Torontosymphony'}(\sigma_{\text{artist}='Zukerman'}((\rho_{\text{name} \leftarrow \text{hall}, \text{capacity} \leftarrow \text{attendance}} \text{Show}) \bowtie \text{Hall}))))$$

(6) List all artists who never played in Toronto.

```
SELECT S.artist
FROM Show S
WHERE NOT EXISTS (SELECT *
                  FROM Hall H
                  WHERE S.hall = H.name
                  AND H.city = 'Toronto')
```

or

```
(SELECT artist
FROM Show)
MINUS
(SELECT artist
FROM Show, Hall
WHERE hall = name
AND city = 'Toronto')
```

$(\pi_{artist} Show) - (\pi_{artist}(\sigma_{city='Toronto'}((\rho_{name \leftarrow hall} Show) \bowtie Hall)))$

(7) List all artists who only played in Toronto.

```
SELECT S.artist
FROM Show S
WHERE NOT EXISTS (SELECT *
                  FROM Hall H
                  WHERE S.hall = H.name
                  AND H.city <> 'Toronto')
```

or

```
(SELECT artist
FROM Show)
MINUS
(SELECT artist
FROM Show, Hall
WHERE hall = name
AND city <> 'Toronto')
```

$(\pi_{artist} Show) - (\pi_{artist}(\sigma_{city \neq 'Toronto'}((\rho_{name \leftarrow hall} Show) \bowtie Hall)))$

(8) List shows that played in every city in Québec.

Assuming $\langle \text{title}, \text{artist}, \text{hall}, \text{attendance} \rangle$ is key of Show relation

```
SELECT S.title, S.artist, S.hall, S.attendance
FROM Show S
WHERE NOT EXISTS (SELECT *
                  FROM City C
                  WHERE C.province = 'Quebec'
                  AND NOT EXISTS (SELECT *
                                 FROM Hall H
                                 WHERE S.hall = H.name
                                 AND H.city = C.name))
```

$$Show - \pi_{\text{title}, \text{artist}, \text{hall}, \text{attendance}} (\pi_{\text{city}, \text{title}, \text{artist}, \text{hall}, \text{attendance}} (Show \times City) - \pi_{\text{city}, \text{title}, \text{artist}, \text{hall}, \text{attendance}} (Show \bowtie (\rho_{\text{hall} \leftarrow \text{name}} Hall) \bowtie (\sigma_{\text{province} = 'Quebec'} (\rho_{\text{city} \leftarrow \text{name}} City))))$$

Write the following 2 queries in both Relational Algebra and Relational Calculus. Same rules as before apply to Relational Algebra queries.

(9) Find artists who performed in two different cities with the same name, but located in different provinces of the same country.

Relational Algebra:

$$\pi_{\text{artist}} (\sigma_{(\text{province1} \neq \text{province2})} (\pi_{\text{artist}, \text{city}, \text{country}, \text{province1}} (\rho_{\text{hall1} \leftarrow \text{hall}} Show) \bowtie (\rho_{\text{hall1} \leftarrow \text{name}, \text{province1} \leftarrow \text{province}} Hall) \bowtie (\rho_{\text{city} \leftarrow \text{name}, \text{province1} \leftarrow \text{province}} (City))) \bowtie (\pi_{\text{artist}, \text{city}, \text{country}, \text{province2}} ((\rho_{\text{hall2} \leftarrow \text{hall}} Show) \bowtie (\rho_{\text{hall2} \leftarrow \text{name}, \text{province2} \leftarrow \text{province}} Hall) \bowtie (\rho_{\text{city} \leftarrow \text{name}, \text{province2} \leftarrow \text{province}} (City))))))$$

Relational Calculus:

$$\{ \text{Artist1} \mid \begin{aligned} & \exists \text{Title1}, \text{Hall1}, \text{Attendance1}, \text{Show}(\text{Title1}, \text{Artist1}, \text{Hall1}, \text{Attendance1}) \wedge \\ & \exists \text{Name1}, \text{City1}, \text{Province1}, \text{Capacity1}, \text{Hall}(\text{Name1}, \text{City1}, \text{Province1}, \text{Capacity1}) \wedge \\ & \exists \text{Cname1}, \text{Cprovince1}, \text{Ccountry1}, \text{City}(\text{Cname1}, \text{Cprovince1}, \text{Ccountry1}) \wedge \\ & \exists \text{Title2}, \text{Artist2}, \text{Hall2}, \text{Attendance2}, \text{Show}(\text{Title2}, \text{Artist2}, \text{Hall2}, \text{Attendance2}) \wedge \\ & \exists \text{Name2}, \text{City2}, \text{Province2}, \text{Capacity2}, \text{Hall}(\text{Name2}, \text{City2}, \text{Province2}, \text{Capacity2}) \wedge \\ & \exists \text{Cname2}, \text{Cprovince2}, \text{Ccountry2}, \text{City}(\text{Cname2}, \text{Cprovince2}, \text{Ccountry2}) \wedge \\ & \text{Name1} = \text{Hall1} \wedge \text{Name2} = \text{Hall2} \wedge \text{City1} = \text{City2} \wedge \\ & \text{Name1} = \text{Cname1} \wedge \text{Cprovince1} = \text{Province1} \wedge \\ & \text{Name2} = \text{Cname2} \wedge \text{Cprovince2} = \text{Province2} \wedge \\ & \text{Artist1} = \text{Artist2} \wedge \text{Province1} \neq \text{Province2} \wedge \text{Ccountry1} = \text{Ccountry2} \end{aligned}$$

(10) Find artists all of whose shows are sold out.

Relational Algebra:

$\pi_{artist} Show - \pi_{artist}(\sigma_{attendance < capacity}((\rho_{name \leftarrow hall} Show) \bowtie Hall))$

Relational Calculus:

$\{Artist \mid \forall Title, Hall, Attendance, Show(Title, Artist, Hall, Attendance)$
 $\exists Name, City, Province, Capacity, (Hall(Name, City, Province, Capacity)$
 $\wedge Name = Hall \wedge Capacity > Attendance)\}$

TOTAL: 150 points.