

Here are some relations that exist in a database for an orchestra.

Person(email, name, age)

- This relation stores anyone who has signed up for our mailing list. Tuples in this relation may not be listed in Purchase.

Show(id, year, month, day, showing, attendanceNumber)

- Showing describes whether a show was during morning, afternoon, or evening
- {year, month, day, showing} is a candidate key for Show

Song(composer, title)

SongsPerformed(showID, composer, title)

- showID is a foreign key referring to Show
- composer and title are foreign keys referring to attributes of the same name in Song

Purchase(email, showID, price)

- email is a foreign key referring to the email attribute in Person
- showID is a foreign key referring to Show

Musician(id, name, instrument, position, nationality)

PerformedIn(id, showID)

- id refers to the attribute of the same name in Musician
- showID is a foreign key referring to Show

Consider the following query meant to find songs that have been performed by every violinist in the orchestra.

```
SELECT DISTINCT composer, title
FROM SongsPerformed sp1
WHERE NOT EXISTS (SELECT *
                  FROM Musician m
                  WHERE NOT EXISTS (
                      SELECT *
                      FROM PerformedIn pi
                      WHERE pi.id = m.id AND pi.showID = sp1.showID AND
                           m.instrument = 'violin'))
```

Riley believes that this query does not work as intended while Alex believes it does. Provide a relational instance that demonstrates why this query does or does not work. Walk through the execution of the query above using your relational instance to prove your point. Your relational instance does not need to include every attribute (though you certainly can if you wish).

Consider the following relational instances.

SongsPerformed

ShowID	Composer	Title
1	Bizet	Carmen
1	Mozart	Eine kleine Nachtmusik
2	Vivaldi	The Four Seasons
2	Chopin	Nocturne Op. 9 No. 2
3	Bach	Partita No. 2 in D Minor

Musician (some attributes omitted for brevity)

ID	Instrument
1	Violin
2	Piano
3	Violin

Performed In

ID	ShowID
1	1
3	2
1	2
2	2
1	3
3	3

- ShowID 1 has a single musician playing and that musician is a violinist
- ShowID 2 has all of the musicians playing so any song from this show has been played by all violinists.
- Show ID 3 has two musicians playing and those two musicians happen to be all our violinists so any song from this show should also be included in the final result.

If the division query worked properly, the following should be our answer:

Composer	Title
Vivaldi	The Four Seasons
Chopin	Nocturne Op. 9 No. 2
Bach	Partita No. 2 in D Minor

If we were to use Alex's query, we would also obtain no results. Why?

Here is the query again:

```
SELECT DISTINCT composer, title
FROM SongsPerformed sp1
WHERE NOT EXISTS (SELECT *
                  FROM Musician m
                  WHERE NOT EXISTS (
                      SELECT *
                      FROM PerformedIn pi
                      WHERE pi.id = m.id AND pi.showID = sp1.showID AND
                           m.instrument = 'violin'))
```

The nested query (the one in blue) will always return a result if your musician table includes a non-violinist. Given our relational instance includes a pianist, this means that our inner query returns a result for every tuple in SongsPerformed which causes the NOT EXISTS to return false. Thus, we return no results.

Goal: Find the composer of title of songs that ALL violinists have played

- Another way to phrase this:
find the composer and title of songs that every violinist has played

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- Another way to phrase this:
find the composer and title of songs that every violinist has played
- In RA:

SongsFromShow \leftarrow

$$\pi_{composer, title, pi. id} \left(\rho(PerformedIn, pi) \bowtie_{pi.showID=id} SongsPerformed \right)$$

$$SongsFromShow / \pi_{id} (\sigma_{instrument="violin"}(Musician))$$

SELECT DISTINCT composer, title

FROM SongsPerformed sp1

WHERE NOT EXISTS (SELECT *

FROM Musician m

WHERE NOT EXISTS (SELECT *

FROM PerformedIn pi

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m.instrument = 'violin'))

What we want:

A query to find the songs that ALL violinists have played.

SongsPerformed		
showID	composer	title
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1	Mozart	Eine kleine Nachtmusik
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Musician	
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PerformedIn	
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                  FROM Musician m
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                                    FROM PerformedIn pi
                                    WHERE pi.id = m.id AND pi.showID = sp1.showID AND
                                           m.instrument = 'violin'))
```

Based on the relational instances, if the query really found the songs played by all violinists, we would get:

composer	title
Vivaldi	The Four Seasons
Chopin	Nocturne Op. 9 No. 2
Bach	Partita No. 2 in D Minor

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FROM SongsPerformed sp1
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Musician	
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Musician	
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PerformedIn	
ID	ShowID
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3	2
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SELECT DISTINCT composer, title

FROM SongsPerformed sp1

WHERE NOT EXISTS (SELECT *
FROM Musician m
WHERE NOT EXISTS (SELECT *
FROM PerformedIn pi
WHERE pi.id = m.id AND pi.showID = sp1.showID AND
m.instrument = 'violin'))

Non-violinists are always going to be included in query highlighted in red.

SongsPerformed			Musician		PerformedIn	
showID	composer	title	ID	Instrument	ID	ShowID
1	Bizet	Carmen	1	Violin	1	1
1	Mozart	Eine kleine Nachtmusik	2	Piano	3	2
2	Vivaldi	The Four Seasons	3	Violin	1	2
2	Chopin	Nocturne Op. 9 No. 2			2	2
3	Bach	Partita No. 2 in D Minor			1	3
					3	3

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SELECT DISTINCT composer, title
FROM SongsPerformed sp1
WHERE NOT EXISTS (SELECT *
                  FROM Musician m
                  WHERE NOT EXISTS (SELECT *
                                    FROM PerformedIn pi
                                    WHERE pi.id = m.id AND pi.showID = sp1.showID AND
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PerformedIn	
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SELECT DISTINCT composer, title
FROM SongsPerformed sp1
WHERE NOT EXISTS (SELECT *
                  FROM Musician m
                  WHERE NOT EXISTS (SELECT *
                                    FROM PerformedIn pi
                                    WHERE pi.id = m.id AND pi.showID = sp1.showID AND
                                           m.instrument = 'violin'))
```

If we wanted to go through the rest of the tuples in SongsPerformed, we certainly can but the fact that we have a non-violinist in Musician means that the inner query always returns something.

SongsPerformed		
showID	composer	title
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Musician	
ID	Instrument
1	Violin
2	Piano
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PerformedIn	
ID	ShowID
1	1
3	2
1	2
2	2
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SELECT DISTINCT composer, title
FROM SongsPerformed sp1
WHERE NOT EXISTS (SELECT *
                  FROM Musician m
                  WHERE NOT EXISTS (SELECT *
                                    FROM PerformedIn pi
                                    WHERE pi.id = m.id AND pi.showID = sp1.showID AND
                                           m.instrument = 'violin'))
```

End result:

composer	title
----------	-------

What about this version?

```
SELECT DISTINCT composer, title
FROM SongsPerformed sp1
WHERE NOT EXISTS (
    SELECT *
    FROM Musician m
    WHERE m.instrument = "violin" AND NOT EXISTS (
        SELECT *
        FROM PerformedIn pi
        WHERE pi.id = m.id AND pi.showID = sp1.showID
    )
)
```

What about this version?

```
SELECT DISTINCT composer, title
FROM SongsPerformed sp1
WHERE NOT EXISTS (
    SELECT *
    FROM Musician m
    WHERE m.instrument = "violin" AND NOT EXISTS (
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        WHERE pi.id = m.id AND pi.showID = sp1.showID
    )
)
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What about this version?

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SELECT DISTINCT composer, title
FROM SongsPerformed sp1
WHERE NOT EXISTS (
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    FROM Musician m
    WHERE m.instrument = "violin" AND NOT EXISTS (
        SELECT *
        FROM PerformedIn pi
        WHERE pi.id = m.id AND pi.showID = sp1.showID
    )
)
```

What about this version?

```
SELECT DISTINCT composer, title  
FROM SongsPerformed sp1  
WHERE NOT EXISTS (
```

```
    SELECT *
```

```
    FROM Musician m
```

```
    WHERE m.instrument = "violin" AND NOT EXISTS (
```

```
        SELECT *
```

```
        FROM PerformedIn pi
```

```
        WHERE pi.id = m.id AND pi.showID = sp1.showID
```

```
    )
```

```
)
```

**Only returns a result if
there exists a violinist
who has not performed
in the show the current
song is from.**

```
SELECT DISTINCT composer, title
FROM SongsPerformed sp1
WHERE NOT EXISTS (
    SELECT *
    FROM Musician m
    WHERE m.instrument = "violin" AND NOT EXISTS (
        SELECT *
        FROM PerformedIn pi
        WHERE pi.id = m.id AND pi.showID = sp1.showID
    )
)
```

SongsPerformed

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Musician

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2	Piano
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PerformedIn

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1	1
3	2
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2	2
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Musician

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    WHERE m.instrument = "violin" AND NOT EXISTS (
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    )
)
```

No (3, 1) tuple in PerformedIn which means the inner query will return (3, 'Violin').

SongsPerformed

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Musician

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1	Violin
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  )
)
```

Becomes False

)

SongsPerformed

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Skipping ahead a little
bit...

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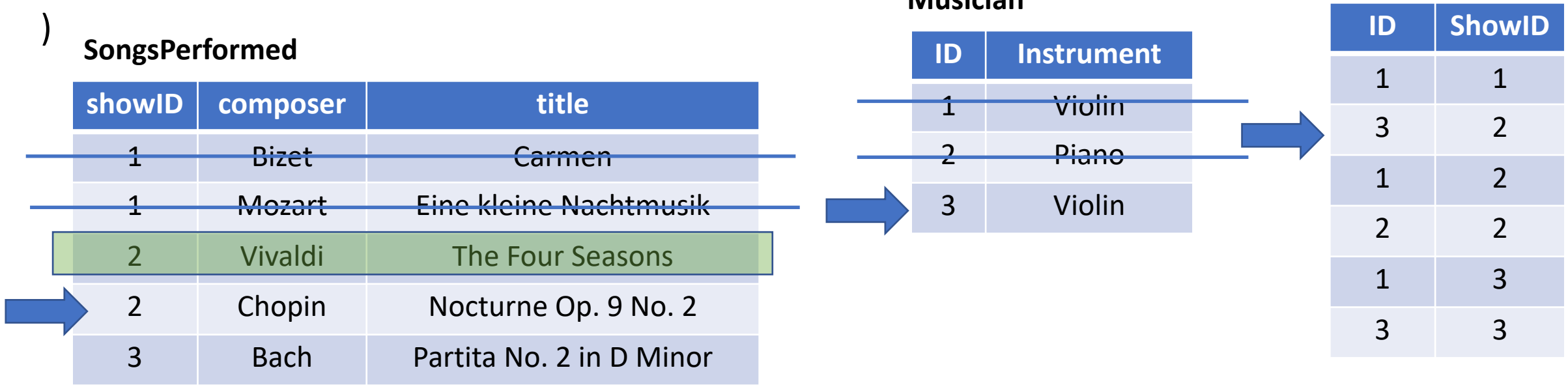
Musician

ID	Instrument
1	Violin
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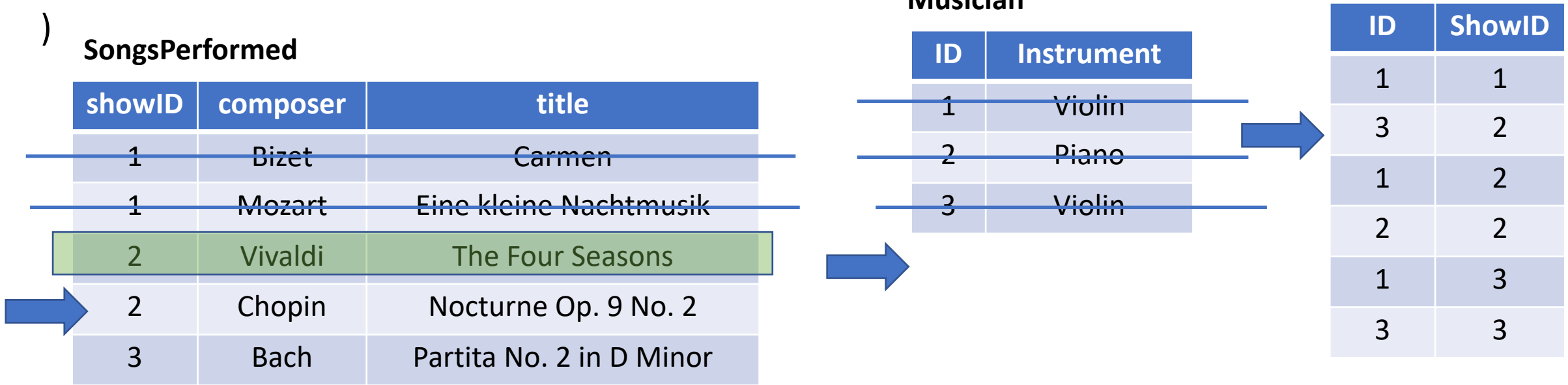
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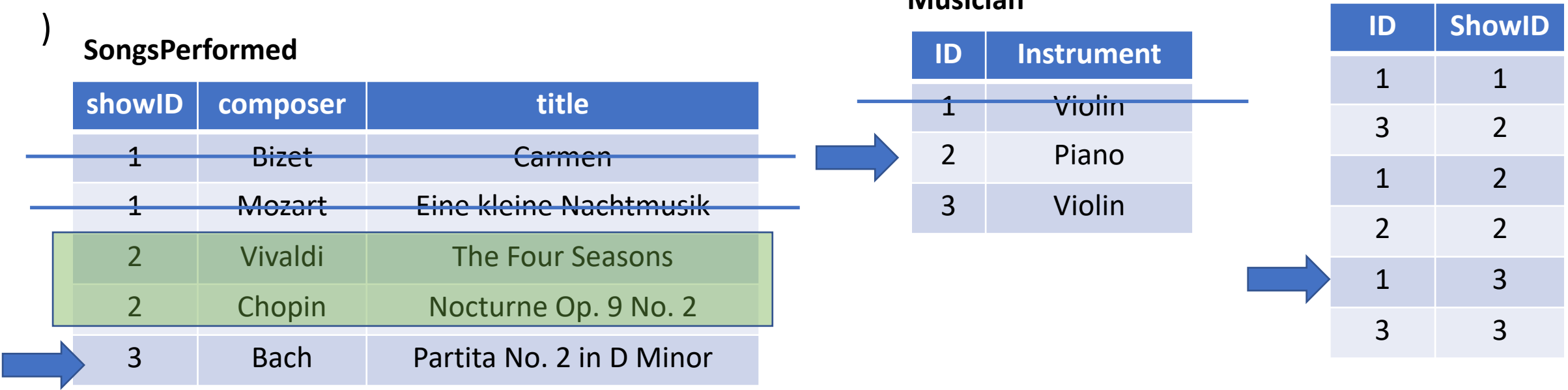
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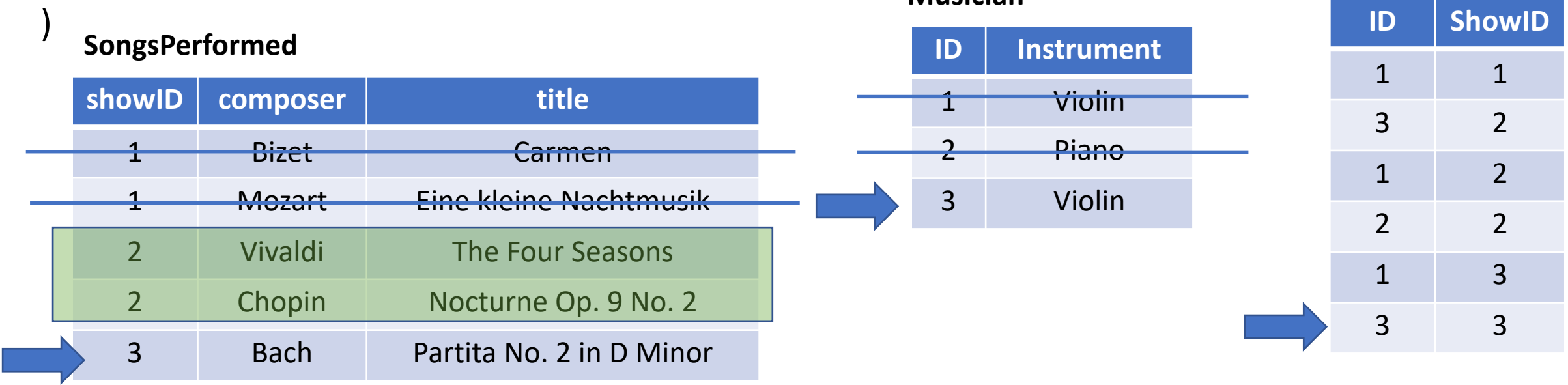
PerformedIn

ID	ShowID
1	1
3	2
1	2
2	2
1	3
3	3

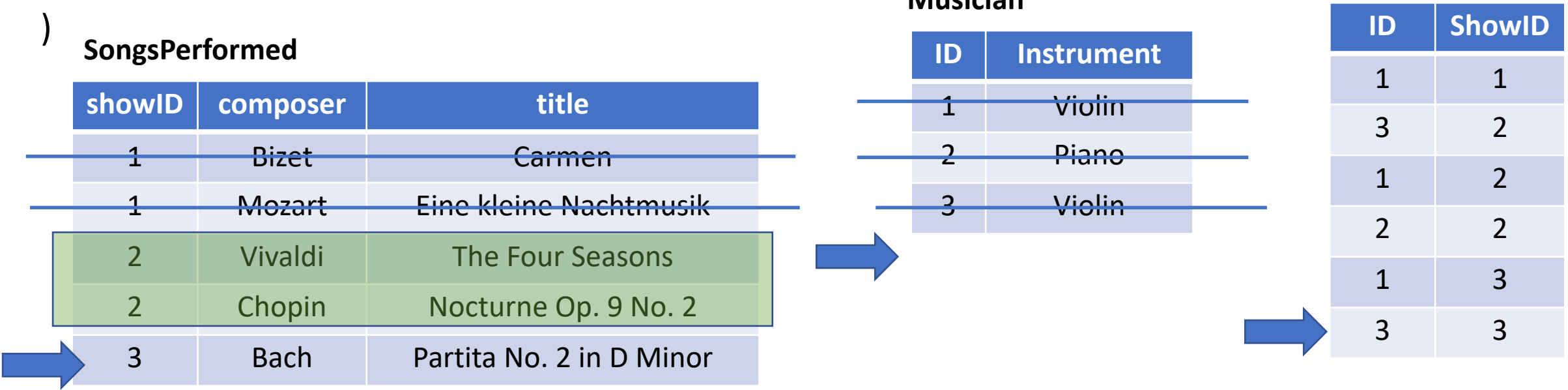
```
SELECT DISTINCT composer, title
FROM SongsPerformed sp1
WHERE NOT EXISTS (
    SELECT *
    FROM Musician m
    WHERE m.instrument = "violin" AND NOT EXISTS (
        SELECT *
        FROM PerformedIn pi
        WHERE pi.id = m.id AND pi.showID = sp1.showID
    )
)
```



```
SELECT DISTINCT composer, title
FROM SongsPerformed sp1
WHERE NOT EXISTS (
    SELECT *
    FROM Musician m
    WHERE m.instrument = "violin" AND NOT EXISTS (
        SELECT *
        FROM PerformedIn pi
        WHERE pi.id = m.id AND pi.showID = sp1.showID
    )
)
```



```
SELECT DISTINCT composer, title
FROM SongsPerformed sp1
WHERE NOT EXISTS (
    SELECT *
    FROM Musician m
    WHERE m.instrument = "violin" AND NOT EXISTS (
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        FROM PerformedIn pi
        WHERE pi.id = m.id AND pi.showID = sp1.showID
    )
)
```



```
SELECT DISTINCT composer, title
FROM SongsPerformed sp1
WHERE NOT EXISTS (
    SELECT *
    FROM Musician m
    WHERE m.instrument = "violin" AND NOT EXISTS (
        SELECT *
        FROM PerformedIn pi
        WHERE pi.id = m.id AND pi.showID = sp1.showID
    )
)
```

SongsPerformed

showID	composer	title
1	Bizet	Carmen
1	Mozart	Eine kleine Nachtmusik
2	Vivaldi	The Four Seasons
2	Chopin	Nocturne Op. 9 No. 2
3	Bach	Partita No. 2 in D Minor

Musician

ID	Instrument
1	Violin
2	Piano
3	Violin

PerformedIn

ID	ShowID
1	1
3	2
1	2
2	2
1	3
3	3




```
SELECT DISTINCT composer, title
FROM SongsPerformed sp1
WHERE NOT EXISTS (
    SELECT *
    FROM Musician m
    WHERE m.instrument = "violin" AND NOT EXISTS (
        SELECT *
        FROM PerformedIn pi
        WHERE pi.id = m.id AND pi.showID = sp1.showID
    )
)
```

What happens if you have the following instances?

)

SongsPerformed		
showID	composer	title
1	Bizet	Carmen
1	Mozart	Eine kleine Nachtmusik
2	Vivaldi	The Four Seasons
2	Chopin	Nocturne Op. 9 No. 2
3	Bach	Partita No. 2 in D Minor
4	Bizet	Carmen

Musician	
ID	Instrument
1	Violin
2	Piano
3	Violin

PerformedIn	
ID	ShowID
1	1
3	2
2	2
1	3
3	3
3	4

```
SELECT DISTINCT composer, title
FROM SongsPerformed sp1
WHERE NOT EXISTS (
    SELECT *
    FROM Musician m
    WHERE m.instrument = "violin" AND NOT EXISTS (
        SELECT *
        FROM PerformedIn pi
        WHERE pi.id = m.id AND pi.showID = sp1.showID
    )
)
```

What happens if you have the following instances?

) **SongsPerformed**

showID	composer	title
1	Bizet	Carmen
1	Mozart	Eine kleine Nachtmusik
2	Vivaldi	The Four Seasons
2	Chopin	Nocturne Op. 9 No. 2
3	Bach	Partita No. 2 in D Minor
4	Bizet	Carmen

Musician

ID	Instrument
1	Violin
2	Piano
3	Violin

PerformedIn

ID	ShowID
1	1
3	2
2	2
1	3
3	3
3	4

```
SELECT DISTINCT composer, title
FROM SongsPerformed sp1
WHERE NOT EXISTS (
    SELECT *
    FROM Musician m
    WHERE m.instrument = "violin" AND NOT EXISTS (
        SELECT *
        FROM PerformedIn pi
        WHERE pi.id = m.id AND pi.showID = sp1.showID
    )
)
```

What happens if you have the following instances?

)

SongsPerformed		
showID	composer	title
1	Bizet	Carmen
1	Mozart	Eine kleine Nachtmusik
2	Vivaldi	The Four Seasons
2	Chopin	Nocturne Op. 9 No. 2
3	Bach	Partita No. 2 in D Minor
4	Bizet	Carmen

Musician	
ID	Instrument
1	Violin
2	Piano
3	Violin

PerformedIn	
ID	ShowID
1	1
3	2
2	2
1	3
3	3
3	4

```
SELECT DISTINCT composer, title
FROM SongsPerformed sp1
WHERE NOT EXISTS (
    SELECT *
    FROM Musician m
    WHERE m.instrument = "violin" AND NOT EXISTS (
        SELECT *
        FROM PerformedIn pi
        WHERE pi.id = m.id AND pi.showID = sp1.showID
    )
)
```

What happens if you have the following instances?

)

SongsPerformed		
showID	composer	title
1	Bizet	Carmen
1	Mozart	Eine kleine Nachtmusik
2	Vivaldi	The Four Seasons
2	Chopin	Nocturne Op. 9 No. 2
3	Bach	Partita No. 2 in D Minor
4	Bizet	Carmen

Musician	
ID	Instrument
1	Violin
2	Piano
3	Violin

PerformedIn	
ID	ShowID
1	1
3	2
2	2
1	3
3	3
3	4

```
SELECT DISTINCT composer, title
FROM SongsPerformed sp1
WHERE NOT EXISTS (
    SELECT *
    FROM Musician m
    WHERE m.instrument = "violin" AND NOT EXISTS (
        SELECT *
        FROM PerformedIn pi
        WHERE pi.id = m.id AND pi.showID = sp1.showID
    )
)
```

What happens if you have the following instances?

This query is good for finding songs from shows where all the violinists have played but this is different from finding all the songs that every violinist has played.

SongsPerformed

showID	composer	title
1	Bizet	Carmen
1	Mozart	Eine kleine Nachtmusik
2	Vivaldi	The Four Seasons
2	Chopin	Nocturne Op. 9 No. 2
3	Bach	Partita No. 2 in D Minor
4	Bizet	Carmen

Musician

ID	Instrument
1	Violin
2	Piano
3	Violin

PerformedIn

ID	ShowID
1	1
3	2
2	2
1	3
3	3
3	4

```
SELECT s.composer, s.title
FROM Song s
WHERE NOT EXISTS (
    SELECT *
    FROM Musician m
    WHERE m.instrument = "violin" AND NOT EXISTS (
        SELECT *
        FROM PerformedIn pi, SongsPerformed sp
        WHERE pi.showID = sp.showID AND m.id = pi.id AND sp.composer = s.composer
        AND sp.title = s.title
```

Does this work?

)

showID	composer	title
1	Bizet	Carmen
1	Mozart	Eine kleine Nachtmusik
2	Vivaldi	The Four Seasons
2	Chopin	Nocturne Op. 9 No. 2
3	Bach	Partita No. 2 in D Minor
4	Bizet	Carmen

ID	Instrument
1	Violin
2	Piano
3	Violin

ID	ShowID
1	1
3	2
2	2
1	3
3	3
3	4

What about this version?

SELECT DISTINCT composer, title
FROM SongsPerformed sp, PerformedIn pi
WHERE sp.id = pi.showID AND pi.id = 1

INTERSECT

SELECT DISTINCT composer, title
FROM SongsPerformed sp, PerformedIn pi
WHERE sp.id = pi.showID AND pi.id = 3

Musician

ID	Instrument
1	Violin
2	Piano
3	Violin

PerformedIn

ID	ShowID
1	1
3	2
1	2
2	2
1	3
3	3

SongsPerformed

showID	composer	title
1	Bizet	Carmen
1	Mozart	Eine kleine Nachtmusik
2	Vivaldi	The Four Seasons
2	Chopin	Nocturne Op. 9 No. 2
3	Bach	Partita No. 2 in D Minor

What about this version?

```
SELECT DISTINCT composer, title
FROM SongsPerformed sp, PerformedIn pi
WHERE sp.id = pi.showID AND pi.id = 1
```

INTERSECT

```
SELECT DISTINCT composer, title
FROM SongsPerformed sp, PerformedIn pi
WHERE sp.id = pi.showID AND pi.id = 3
```

composer	title
Bizet	Carmen
Mozart	Eine kleine Nachtmusik
Vivaldi	The Four Seasons
Chopin	Nocturne Op. 9 No. 2
Bach	Partita No. 2 in D Minor

Musician

ID	Instrument
1	Violin
2	Piano
3	Violin

PerformedIn

ID	ShowID
1	1
3	2
1	2
2	2
1	3
3	3

SongsPerformed

showID	composer	title
1	Bizet	Carmen
1	Mozart	Eine kleine Nachtmusik
2	Vivaldi	The Four Seasons
2	Chopin	Nocturne Op. 9 No. 2
3	Bach	Partita No. 2 in D Minor

What about this version?

SELECT DISTINCT composer, title
FROM SongsPerformed sp, PerformedIn pi
WHERE sp.id = pi.showID AND pi.id = 1

INTERSECT

SELECT DISTINCT composer, title
FROM SongsPerformed sp, PerformedIn pi
WHERE sp.id = pi.showID AND pi.id = 3

composer	title
Vivaldi	The Four Seasons
Chopin	Nocturne Op. 9 No. 2
Bach	Partita No. 2 in D Minor

Musician

ID	Instrument
1	Violin
2	Piano
3	Violin

PerformedIn

ID	ShowID
1	1
3	2
1	2
2	2
1	3
3	3

SongsPerformed

showID	composer	title
1	Bizet	Carmen
1	Mozart	Eine kleine Nachtmusik
2	Vivaldi	The Four Seasons
2	Chopin	Nocturne Op. 9 No. 2
3	Bach	Partita No. 2 in D Minor

What about this version?

```
SELECT DISTINCT composer, title
FROM SongsPerformed sp, PerformedIn pi
WHERE sp.id = pi.showID AND pi.id = 1
```

INTERSECT

```
SELECT DISTINCT composer, title
FROM SongsPerformed sp, PerformedIn pi
WHERE sp.id = pi.showID AND pi.id = 3
```

composer	title
Vivaldi	The Four Seasons
Chopin	Nocturne Op. 9 No. 2
Bach	Partita No. 2 in D Minor

composer	title
Bizet	Carmen
Mozart	Eine kleine Nachtmusik
Vivaldi	The Four Seasons
Chopin	Nocturne Op. 9 No. 2
Bach	Partita No. 2 in D Minor

INTERSECT

composer	title
Vivaldi	The Four Seasons
Chopin	Nocturne Op. 9 No. 2
Bach	Partita No. 2 in D Minor

What about this version?

```
SELECT composer, title  
FROM SongsPerformed sp, PerformedIn pi  
WHERE sp.id = pi.showID AND pi.id = 1
```

INTERSECT

```
SELECT composer, title  
FROM SongsPerformed sp, PerformedIn pi  
WHERE sp.id = pi.showID AND pi.id = 3
```

composer	title
Vivaldi	The Four Seasons
Chopin	Nocturne Op. 9 No. 2
Bach	Partita No. 2 in D Minor

What about this version?

```
SELECT composer, title
FROM SongsPerformed sp, PerformedIn pi
WHERE sp.id = pi.showID AND pi.id = 1
```

INTERSECT

```
SELECT composer, title
FROM SongsPerformed sp, PerformedIn pi
WHERE sp.id = pi.showID AND pi.id = 3
```

What happens when a violinist is added/removed?

composer	title
Vivaldi	The Four Seasons
Chopin	Nocturne Op. 9 No. 2
Bach	Partita No. 2 in D Minor

What about this version?

```
SELECT DISTINCT composer, title  
FROM SongsPerformed sp, PerformedIn pi  
WHERE sp.id = pi.showID AND (pi.id = 1 OR pi.id = 3)
```

What about this version?

```
SELECT DISTINCT composer, title  
FROM SongsPerformed sp, PerformedIn pi  
WHERE sp.id = pi.showID AND (pi.id = 1 OR pi.id = 3)
```

This gives you any song performed by either musician id 1 or musician id 3.