

Name

UIN

Homework Assignment 1

Due Date: Monday, Feb 16, 2026

CS480 - Database Systems

Please leave this empty!

1.1		1.2		1.3		1.4		1.5		1.6	
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1.7		1.8		1.9		1.10		1.11		1.12	
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Instructions

- Try to answer all the questions using what you have learned in class
- **When writing a query, write the query in a way that it would work over all possible database instances and not just for the given example instance!**
- Some questions are marked as bonus. You do not have to answer these questions to get full points for the assignment. However, you can get bonus points for these questions!
- **Please submit the homework electronically using gradescope**
- **Submissions will be automatically graded. You can submit multiple times.**

Solutions for this question have to be written in the provided text files (e.g., `q1.1.1.ra` for question 1.1.1. Relational algebra expressions are written in the format of the `radb` python package (<https://users.cs.duke.edu/~junyang/radb/start.html>). To test your code, install this package and use it to connect to a database (the autograder uses Postgres: <https://www.postgresql.org/>) that has the provide example schema and data (load `homework_1.sql`). For example, $\pi_{title}(songs)$ would be written as follows in `radb`'s dialect:

```
\project_{title}(songs)
```

Consider the following database schema and example instance:

songs

songid	title	genre	duration	releasedate	bandid
101	Bohemian Rhapsody	Rock	354	1975-10-31	1
102	Under Pressure	Rock	248	1981-10-26	1
103	Under Pressure	Rock	248	1981-10-26	2
104	Numb/Encore	Hip-Hop	212	2004-11-30	3

platforms

platformid	platformname	type	unitrevenue
10	Spotify	audio	1.00
20	YouTube	video	1.00
30	Apple Music	audio	2.00
40	SoundCloud	audio	3.00

bands

id	name	label
1	Queen	EMI
2	David Bowie	RCA
3	Linkin Park	Warner
4	Jay-Z	Roc-A-Fella

streams_daily

songid	bandid	platformid	streamdate	streamcount
101	1	10	2025-01-01	1500
102	1	10	2025-01-02	1500
103	2	30	2025-01-01	1050
104	3	20	2025-01-01	1800

Hints:

- Attributes shown with grey background are the **primary key** of a relation.
- Attribute *songid* of relation *streams_daily* is a foreign key to relation *songs*.
- Attribute *bandid* of relation *streams_daily* is a foreign key to relation *bands*.
- Attribute *platformid* of relation *streams_daily* is a foreign key to relation *platforms*.
- Attribute *bandid* of relation *songs* is a foreign key to relation *bands*.

Part 1.1 Relational Algebra (Total: 100 + 10 bonus Points)

Question 1.1.1 (6 Points)

Write a relational algebra expression that returns the `title`, `releasedate`, and `duration` of all *Rock* genre songs.

Question 1.1.2 (6 Points)

Write a relational algebra expression that returns the songs longer than 4 minutes. Note that in the song table, durations are specified in seconds.

Question 1.1.3 (8 Points)

Write a relational algebra expression that returns `title`, `platformname`, `bandname`, `streamdate`, and `streamcount` of all the songs released by the *EMI* label.

Question 1.1.4 (10 Points)

Write a relational algebra expression that returns the **genre** with the highest total number of streams across all platforms and dates.

Question 1.1.5 (10 Points)

Write a relational algebra expression that returns the **songid**, **title**, and **releasedate** of the **oldest released song** that was streamed at least once in the year 2025.

Question 1.1.6 (10 Points)

Write a relational algebra expression that returns pairs of bands (**band1**, **band2**) such that the two bands have **collaborated on at least one song**.

Question 1.1.7 (10 Points)

Write a relational algebra expression that returns the `songid` and `title` of songs that have never been streamed on Spotify or YouTube.

Question 1.1.8 (10 Points)

Write a relational algebra expression that returns the most profitable label per platform type. The profit can be calculated as `streamcount` times `unitrevenue`.

Question 1.1.9 (10 Points)

Write a relational algebra expression that returns the song and band with the above-average total streams.

Question 1.1.10 (10 Points)

Write a relational algebra expression that returns the top 2 songs per platform. The popularity of a song on a platform is measured as its total stream count.

Question 1.1.11 (10 Points)

Write a relational algebra expression that returns all the bands with above-average profits. The profit of a band is calculated as follows. For each stream of one of the band's songs on a platform X the band receives the `unitrevenue` for this platform.

Question 1.1.12 BONUS QUESTION (10 Points)

Write a relational algebra expression that returns, for each band, a **timeline of streaming activity**.

The result schema should be:

`(bandid, startdate, enddate, total_streams)`

Each returned tuple should represent the **largest possible interval of consecutive dates (inclusive)** during which the total number of streams for the band remains unchanged.

For example, if a band has total streams 100 on Jan 1 and Jan 2, and 150 on Jan 3, then the interval (Jan 1, Jan 2, 100) should be returned.

Hint: You may find it useful to first identify all dates on which the streaming activity of a band changes, and then construct maximal intervals between such dates.