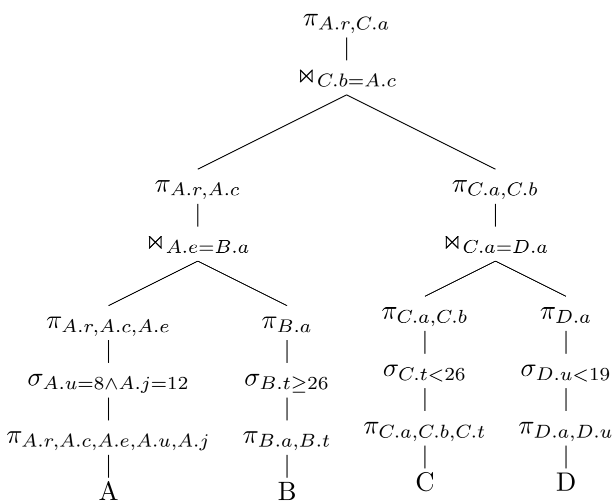
Leo Forster
Maximilian Prinz
Bastian Simon

1. From SQL to the Logical Plan

2. Heuristic Query Optimisation

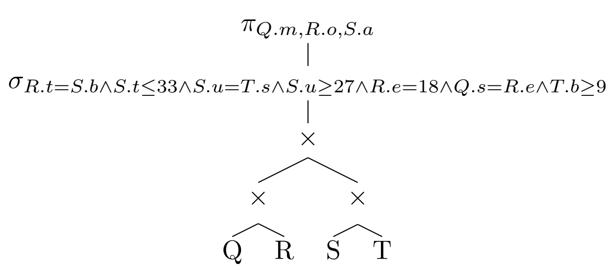
2.1 (a)

Applying predicate and projection pushdown:



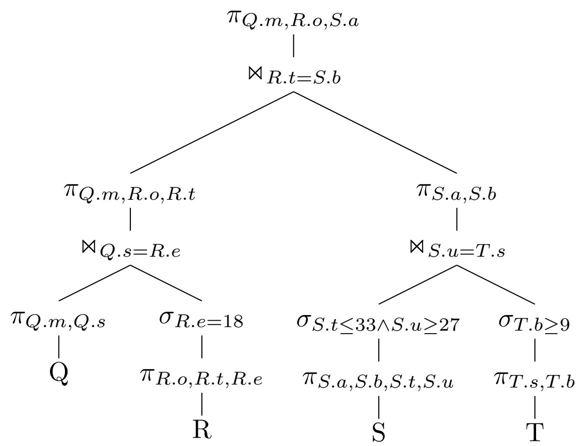
2.2 (b)

2.2.1



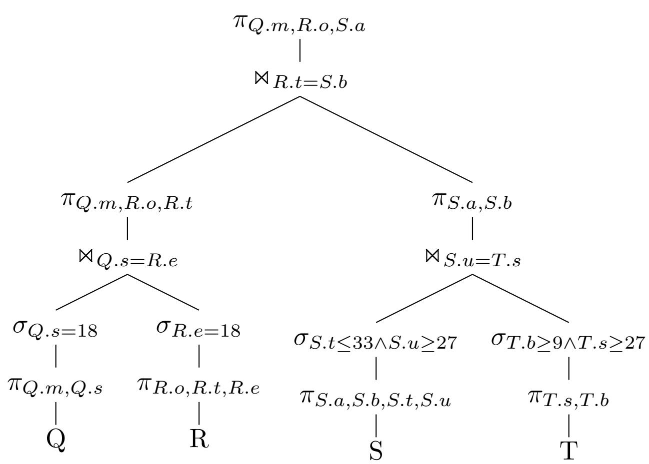
2.2.2

Applying predicate and projection pushdown:



2.2.3

Since we defined predicates on attributes used in joins, we can also apply and push down those predicates on the key-attributes of the opposing relation.



1 From SQL to the Logical Plan (5 Points)

In this exercise, we want to optimise a SQL query based on the following schemas using the rules presented in the lecture.

[persons] : {[<u>pid: int</u>, name: varchar, birth_year: int]}
[libraries] : {[<u>lid: int</u>, city: varchar]}
[members] : {[<u>mid: (persons)</u>, favorite_author: (authors), late_fees: int]}
[membership] : {[<u>member: (members), library: (libraries)</u>]}
[authors] : {[<u>aid: (persons)</u>, salary: int]}
[books] : {[<u>bid: int</u>, author: (authors), title: varchar, year: int, genre: varchar]}
[borrow] : {[<u>member: (members), library: (libraries), book: (books)</u>, borrow_date: date, due_date: date]}
[reserve] : {[<u>member: (members), library: (libraries), book: (books), reservation_date: date</u>]}

```sql
SELECT favorite_author, reservation_date, year
FROM   books, reserve, members
WHERE  book = bid
       AND member = mid
       AND late_fees > 20
       AND title = 'The Da Vinci Code'
       AND reservation_date = '24.02.2024';
```

(a) Translate the SQL query canonically into a relational algebra expression. Use only projections, selections and Cartesian products. (1 Point)

(b) Draw the logical plan of the query as a tree. (1 Point)

(c) Apply the rules for heuristic query optimisation known from the lecture and the notebook Rule-based Optimization.ipynb and draw the optimised logical plan of the query as a tree. (3 Points)

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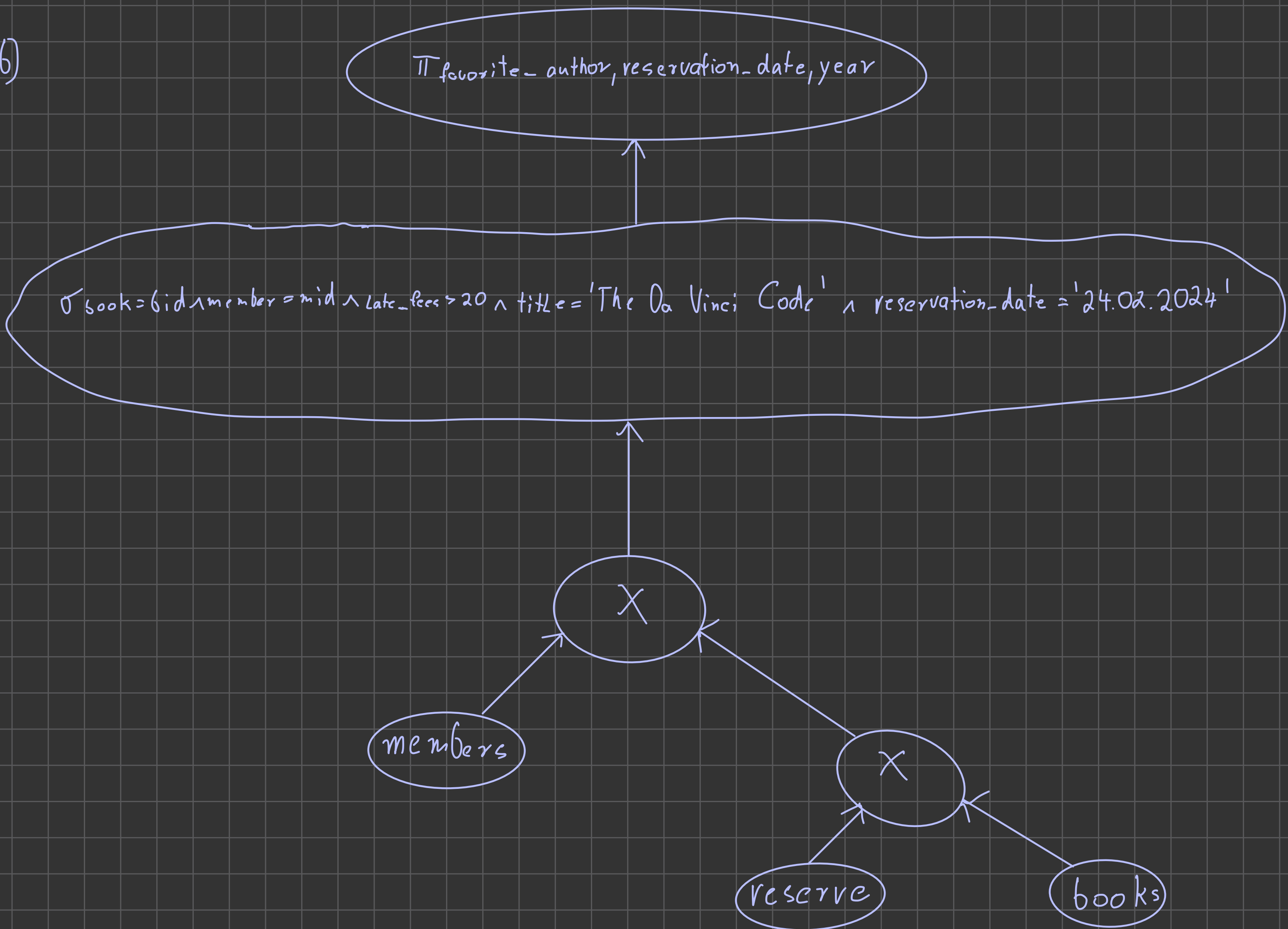
a)

$R_1 := (members \times (reserve \times books)))$

$R_2 := \sigma_{book=bid \wedge member=mid \wedge late\_fees>20 \wedge title='The\ Da\ Vinci\ Code' \wedge reservation\_date='24.02.2024'}\ R_1$

$\pi_{favorite\_author,\ reservation\_date,\ year}\ R_2$

b)



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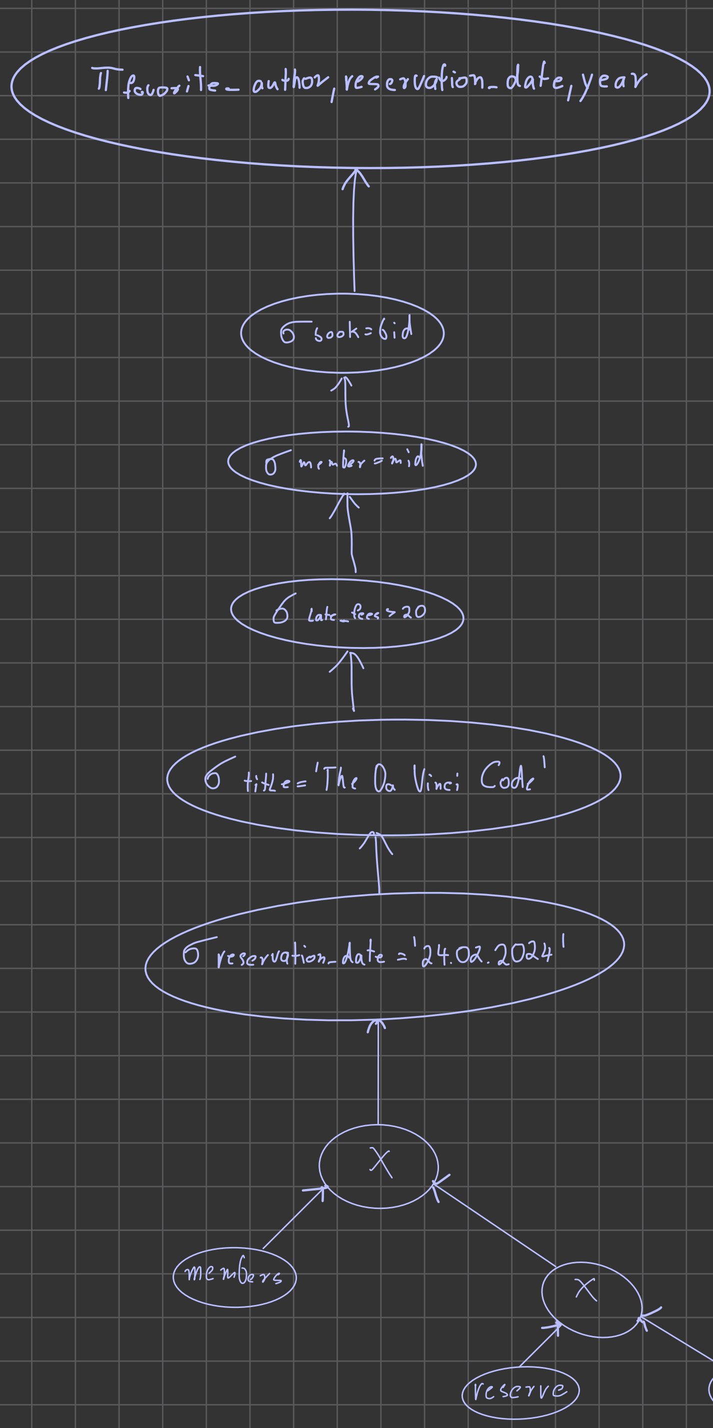
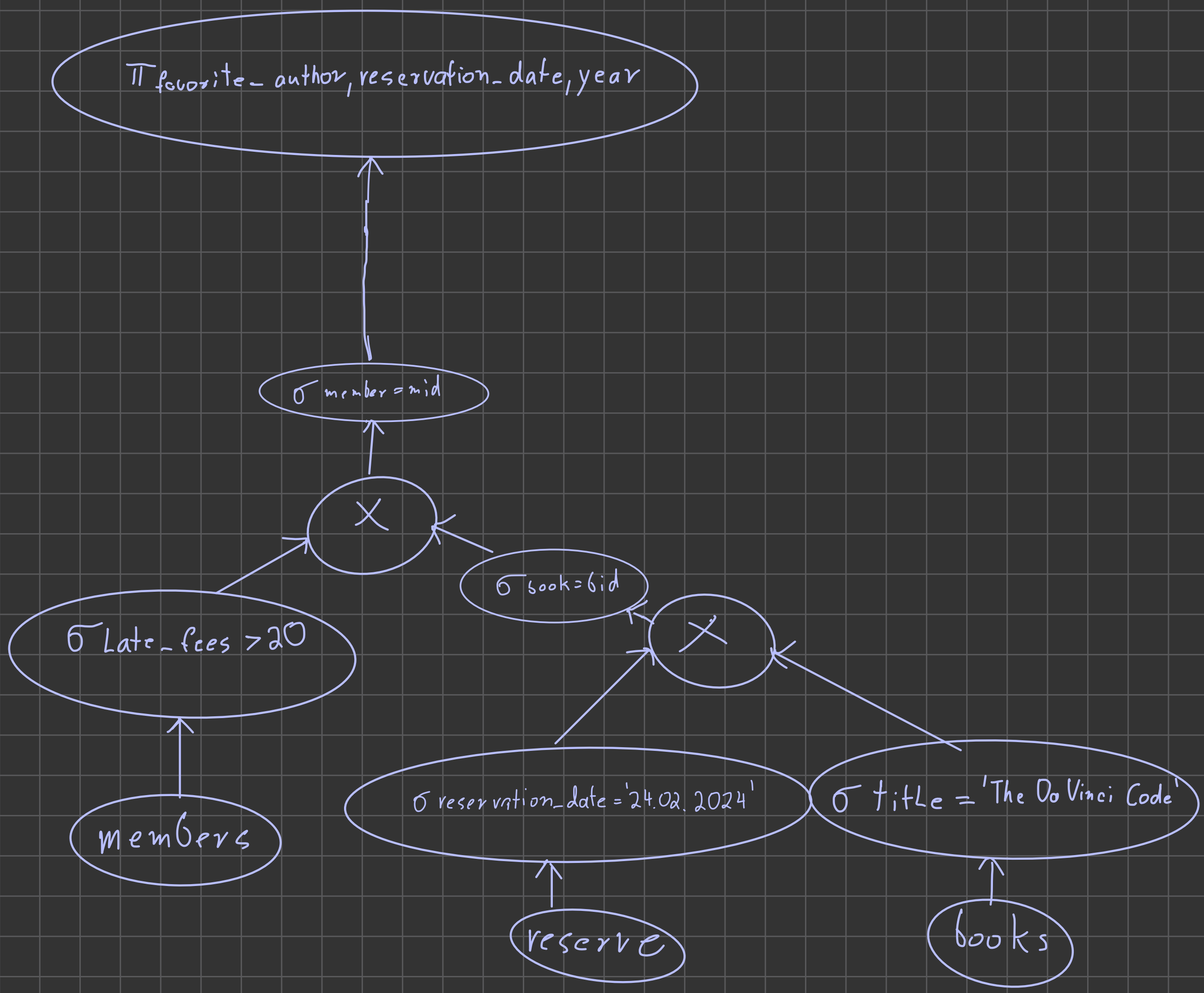
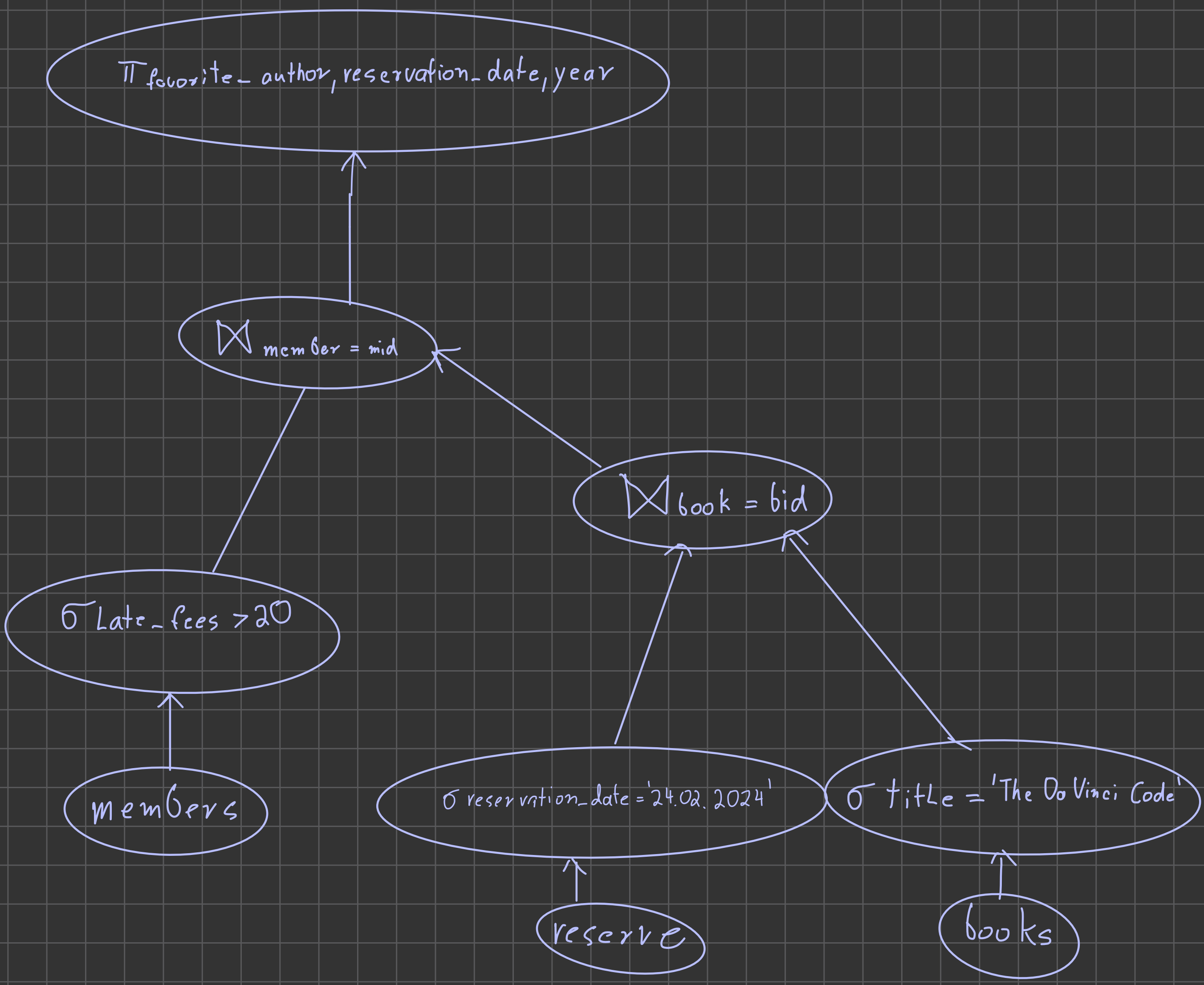
c) 1. Break up and selections



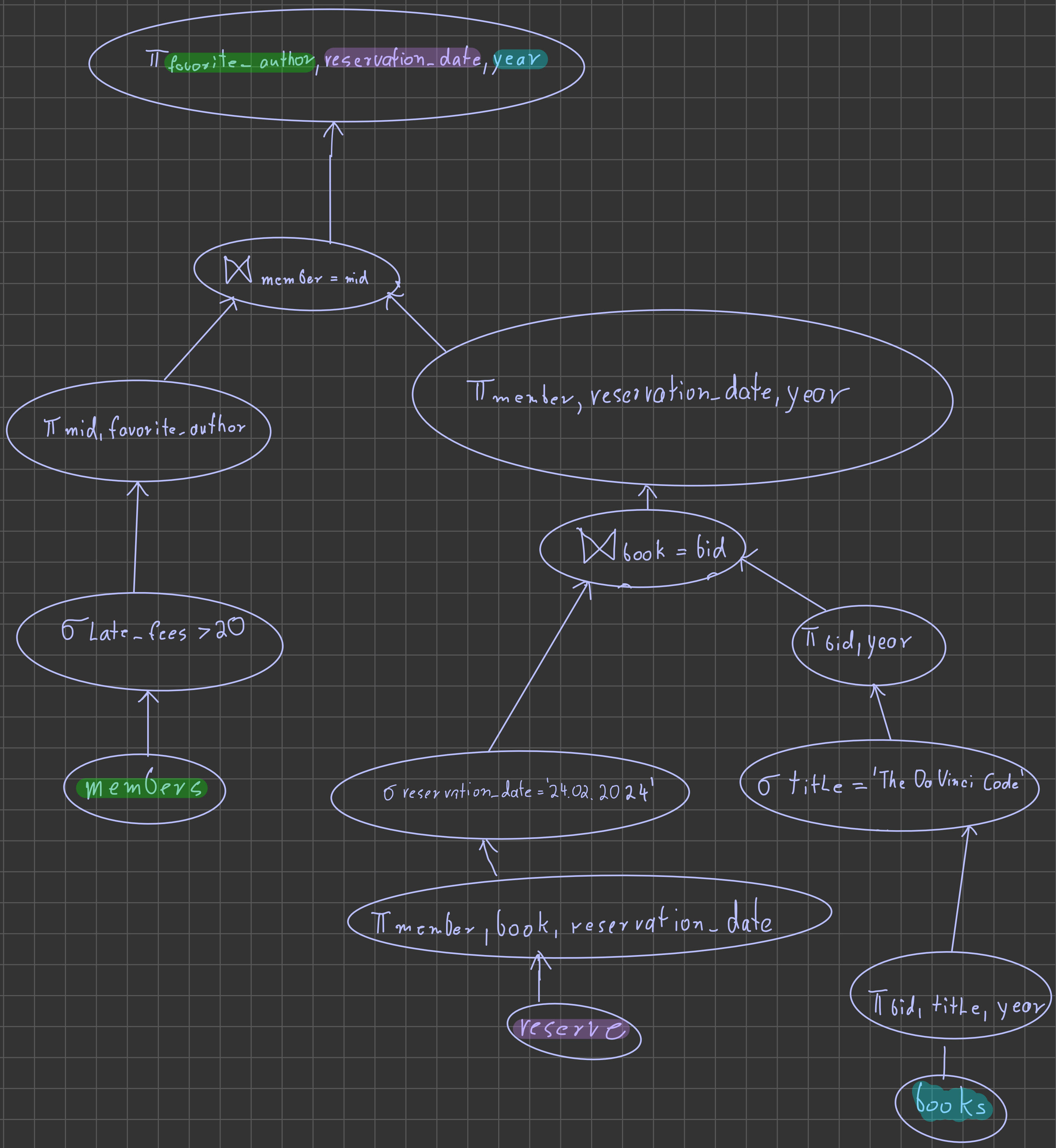
c) 2. Push down selections



c) 3. Replace a join style selection on top of a cartesian product by a theta join



c) 4. Insert projections



Exercise 3

1) The problem arises due to the violation of the principle of projection pushdown. Projecting the book column before applying the GROUP BY and having clauses can lead to unnecessary computation and performance issues.
2) To fix the problem, we could first apply the aggregation and filtering operations and then project the columns. If we do this, the aggregation is only performed for the relevant data and in the end, only the necessary columns are included.