DDL commands

```
-- Create the School table
CREATE TABLE School (
    schoolId INT PRIMARY KEY,
    schoolName VARCHAR(100),
    schoolCity VARCHAR(100)
);

-- Create the Boards table
CREATE TABLE Boards (
    boardId INT PRIMARY KEY,
    boardName VARCHAR(100)
);

-- Create the TwelfthSpecializations table
CREATE TABLE TwelfthSpecializations (
    specId INT PRIMARY KEY,
    specName VARCHAR(100)
);

-- Create the UndergradFields table
CREATE TABLE UndergradFields (
    fieldId INT PRIMARY KEY,
    fieldName VARCHAR(100)
);

-- Create the MBASpecializations table
CREATE TABLE MBASpecializations (
    specId INT PRIMARY KEY,
    specName VARCHAR(100)
);

-- Create the Students table with foreign key references
CREATE TABLE Students (
    studentId INT PRIMARY KEY,
    gender VARCHAR(10),
    schoolId INT,
    tenthBoardId INT,
    twelfthBoardId INT,
    twelfthSpecId INT,
    ungradFieldId INT,
    MBASpecId INT,
    FOREIGN KEY (schoolId) REFERENCES School(schoolId)
              ON DELETE SET NULL
              ON UPDATE CASCADE,
    FOREIGN KEY (tenthBoardId) REFERENCES Boards(boardId)
              ON DELETE SET NULL
              ON UPDATE CASCADE,
    FOREIGN KEY (twelfthBoardId) REFERENCES Boards(boardId)
```

```
            ON DELETE SET NULL
            ON UPDATE CASCADE,
    FOREIGN KEY (twelfthSpecId) REFERENCES TwelfthSpecializations(specId)
            ON DELETE SET NULL
            ON UPDATE CASCADE,
    FOREIGN KEY (ungradFieldId) REFERENCES UndergradFields(fieldId)
            ON DELETE SET NULL
            ON UPDATE CASCADE,
    FOREIGN KEY (MBASpecId) REFERENCES MBASpecializations(specId)
            ON DELETE SET NULL
            ON UPDATE CASCADE
);

-- Create the EmpStats table
CREATE TABLE EmpStats (
    studentId INT PRIMARY KEY,
    workExperience INT,
    employabilityTest INT,
    FOREIGN KEY (studentId) REFERENCES Students(studentId)
       ON DELETE CASCADE
       ON UPDATE CASCADE
);

-- Create the Grades table
CREATE TABLE Grades (
    studentId INT PRIMARY KEY,
    gender VARCHAR(10),
    tenthPercent INT,
    twelfthPercent INT,
    undergradPercent INT,
    MBAPercent INT,
    FOREIGN KEY (studentId) REFERENCES Students(studentId)
       ON DELETE CASCADE
       ON UPDATE CASCADE
);

-- Create the Placements table
CREATE TABLE Placements (
    studentId INT PRIMARY KEY,
    status VARCHAR(100),
    salary INT,
    FOREIGN KEY (studentId) REFERENCES Students(studentId)
       ON DELETE CASCADE
       ON UPDATE CASCADE
);
```

We used these DDL commands and then inserted data into our tables. This query is to show how many rows are in each of our tables in the database.

```sql
SELECT
  table_name,
  table_rows
FROM
  information_schema.tables
WHERE
  table_schema = 'test';
```

TABLE_NAME	TABLE_ROWS
Boards	2
EmpStats	1017
Grades	1017
MBASpecializations	2
Placements	1017
School	0
Students	1017
TwelfthSpecializations	2
UndergradFields	2

Advanced Query 1:

Function

This query finds the average salary, minimum salary, maximum salary, and most common MBA specialization for a student, given an undergraduate field, specifically Sci&Tech in this example.

Code

```
SELECT
       uf.fieldName AS SelectedDegree,
       AVG(p.salary) AS AvgSalary,
       MIN(p.salary) AS MinSalary,
       MAX(p.salary) AS MaxSalary,
              (
                     SELECT ms.specName
                     FROM MBASpecializations AS ms
                     WHERE ms.specId IN (
                            SELECT s.MBASpecId
                            FROM Students s
                            WHERE s.undergradFieldId = uf.fieldId
                            )
                     GROUP BY ms.specName
                     ORDER BY COUNT(*) DESC
                     LIMIT 1
              ) AS ModeSpecialization

FROM Students AS s LEFT JOIN UndergradFields uf ON s.undergradFieldId =
uf.fieldId
LEFT JOIN Placements AS p ON s.studentId = p.studentId
WHERE uf.fieldName = 'Sci&Tech'
GROUP BY uf.fieldName, ModeSpecialization;
```

Output

SelectedDegree	AvgSalary	MinSalary	MaxSalary	ModeSpecialization
Sci&Tech	554880.4348	200000	850000	Mkt&Fin

*only one row, because there is only one set of values to be returned.

Indexing

This is what our initial EXPLAIN ANALYZE looked like.

We then created an index for MBASpecId in the Students table because it was being used within a boolean operator and count aggregate function to determine the most popular speciality given an undergraduate field, which could increase overall time.

```
CREATE INDEX mba_id_idx on Students(MBASpecId);
```

This is what the EXPLAIN ANALYZE outputted after this index was created.

We then created an index for MBASpecId in the Students table because it was being used within the subquery, possibly increasing the overall time of the query.

```
CREATE INDEX undergrad_id_idx on Students(undergradFieldId);
```

This is what the EXPLAIN ANALYZE outputted after this index was created.

We then created an index for StudentId in the Students table because it was being used within the main query in the FROM clause to join the Student table with the UndergradFields and Placements table.

```
CREATE INDEX stu_id_idx on Students(studentId);
```

This is what the EXPLAIN_ANALYZE outputted after this index was created.

```
-> Table scan on <temporary>  (actual time=82.206..82.206 rows=1 loops=1)
    -> Aggregate using temporary table  (actual time=82.205..82.205 rows=1 loops=1)
        -> Nested loop left join  (cost=229.66 rows=508) (actual time=0.097..1.326 rows=224 loops=1)
            -> Nested loop inner join  (cost=51.69 rows=508) (actual time=0.080..0.230 rows=224 loops=1)
                -> Filter: ((uf.fieldName = 'Sci&Tech') and (uf.fieldId is not null))  (cost=0.45 rows=1) (actual time=0.042..0.047 rows=1 loops=1)
                    -> Table scan on uf  (cost=0.45 rows=2) (actual time=0.033..0.038 rows=2 loops=1)
                -> Covering index lookup on s using undergrad_id_idx (undergradFieldId=uf.fieldId)  (cost=51.24 rows=508) (actual time=0.036..0.160 rows=224 loops=1)
            -> Index lookup on p using pl_student_id_idx (studentId=s.studentId)  (cost=0.25 rows=1) (actual time=0.004..0.004 rows=1 loops=224)
    -> Select #2 (subquery in projection; dependent)
        -> Limit: 1 row(s)  (actual time=0.348..0.348 rows=1 loops=225)
            -> Sort: count(0) DESC, limit input to 1 row(s) per chunk  (actual time=0.348..0.348 rows=1 loops=225)
                -> Table scan on <temporary>  (actual time=0.345..0.345 rows=2 loops=225)
                    -> Aggregate using temporary table  (actual time=0.344..0.344 rows=2 loops=225)
                        -> Nested loop inner join  (cost=102.35 rows=1017) (actual time=0.339..0.341 rows=2 loops=225)
                            -> Table scan on ms  (cost=0.45 rows=2) (actual time=0.002..0.003 rows=2 loops=225)
                            -> Single-row index lookup on <subquery3> using <auto_distinct_key> (MBASpecId=ms.specId, undergradFieldId=uf.fieldId)  (actual time=0.168..0.169 rows=1 loops=450)
                                -> Materialize with deduplication  (cost=105.45..105.45 rows=508) (actual time=0.335..0.335 rows=2 loops=225)
                                    -> Filter: ((s.MBASpecId is not null) and (s.undergradFieldId is not null))  (cost=54.60 rows=508) (actual time=0.096..0.278 rows=224 loops=225)
                                        -> Index lookup on s using undergrad_id_idx (undergradFieldId=uf.fieldId)  (cost=54.60 rows=508) (actual time=0.095..0.249 rows=224 loops=225)
```

We noticed that adding the indexes for these attributes did not improve the cost or time for our query greatly. This is because most of the attributes in the students table are foreign keys that reference other tables and foreign keys are already indexed. Because of this, we decided to not to add any indexes for this query.

Advanced Query 2:

Function

This query finds the most popular twelfth grade specialization among students with a certain salary, specifically above 500000 in this example.

Code

```
SELECT specName
FROM TwelfthSpecializations
WHERE specId IN
(
SELECT ROUND(AVG(t.specId), 0)
FROM Students s LEFT JOIN TwelfthSpecializations t ON s.twelfthSpecId =
t.specId
WHERE studentId IN (SELECT p.studentId FROM Placements p WHERE p.salary >=
500000)
);
```

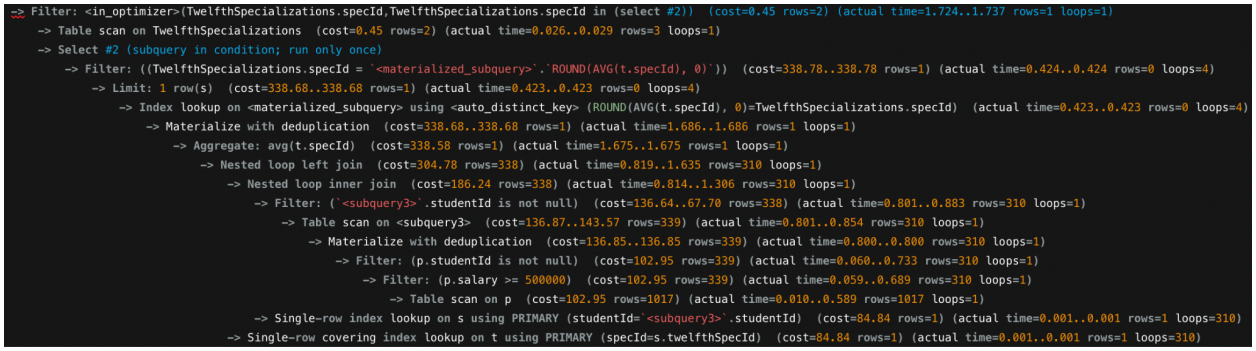
Output

specName
Commerce

*only one row because only one specialization returned

Indexing

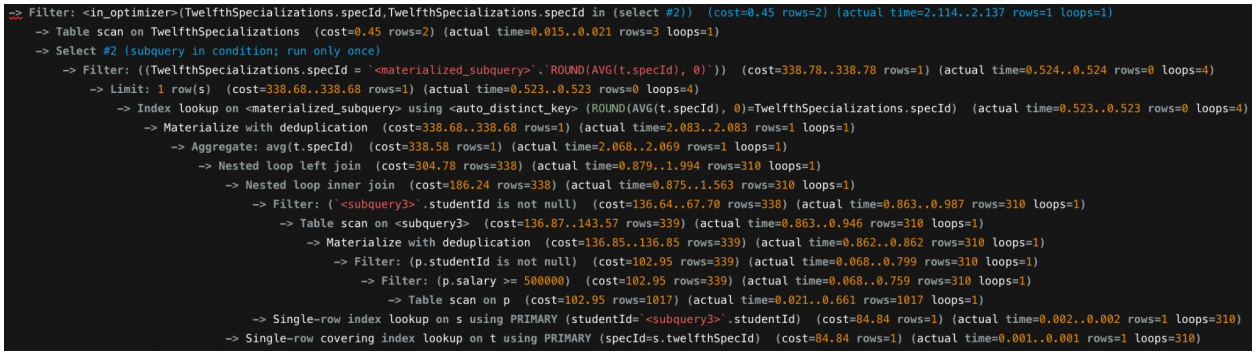
This is what our initial EXPLAIN ANALYZE looked like.



We then created an index for studentId in the Students table because it was being used to join in the query and could have been increasing the cost.

```
CREATE INDEX student_id_idx ON Students(studentId);
```

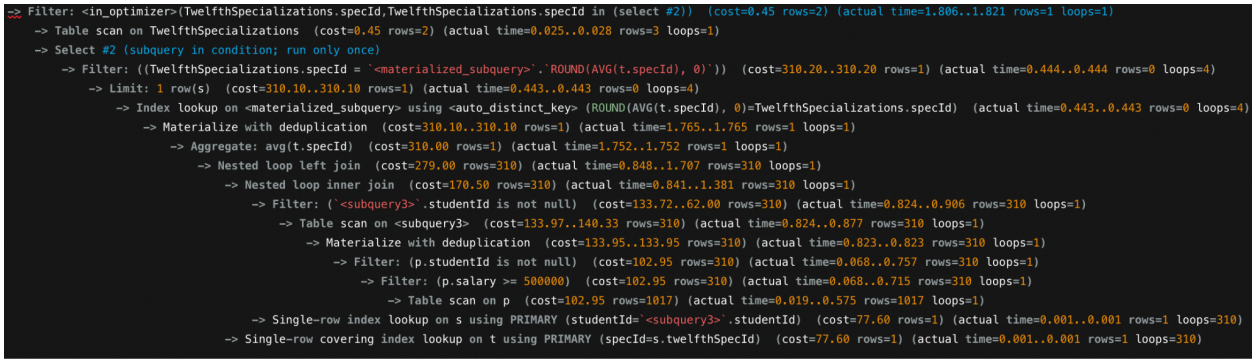
This is what the EXPLAIN ANALYZE outputted after this index was created.



We then created an index for salary in the Placements table because it was being filtered on in the query and could have been increasing the cost.

```
CREATE INDEX salary_idx ON Placements(salary);
```

This is what the EXPLAIN ANALYZE outputted after this index was created.



We then created an index for studentId in the Placements table because it was also being used in the join in the query and could have been increasing the cost.

```
CREATE INDEX pl_student_id_idx ON Placements(studentId);
```

This is what the EXPLAIN ANALYZE outputted after this index was created.

We decided to not add any indexes, i.e., go forward with the default index. We chose this plan because as can be seen in the EXPLAIN ANALYZE outputs above, adding indexes did not significantly change the cost of our query. This happened for two main reasons. One, the query is complex. In queries with complex conditions or joins, the database optimizer may decide that a full table scan is more efficient than using an index because it avoids the overhead of index lookups. Second, some of the attributes we indexed are already primary or foreign keys in the schema and in MySQL this means they are already keys. So, adding them as keys did not change anything in the performance. We still chose to try indexing these attributes because they were the only viable options. In brief, we are choosing to go forward with the default indexing because indexing will not optimize our cost due to the complexity of the query and the nature of our database's relational schema (i.e., the predefined primary and foreign keys).