Exercise 1: Explain the phases of query processing done by relational database management systems.

Exercise 2: Discuss the approach of common DBMS query optimizers. Are the approaches suitable for data warehouses?

1. A data warehouse schema is given, that associates one fact (Verkaeufe) to 3 Dimensions (Zeit, Ort, Produkt). Furthermore, the following meta-data are given:
   - 50.000.000 tuples are inside the fact table.
   - The time dimension contains 10 years (20 days per month).
   - There are 50 product groups each having 20 products.
   - There 50 locations with 100 car-salers each.

The sales are distributed uniformly for all dimensions. Which execution plans are proposed by a common database optimizer regarding the query of Figure 1? Which optimal execution plan is not proposed by standard dbms optimizers?

```sql
SELECT Umsatz
FROM Verkaeufe, Ort, Zeit, Produkt
WHERE Produkt.id = Verkaeufe.Product_id AND
      Produkt.Produktgruppe = 'VW' AND
      Ort.id = Verkaeufe.shop_id AND
      Ort.Region = 'Magdeburg' AND
      Zeit.id = Verkaeufe.day_id AND
      Zeit.Jahr = '2004' OR
      Zeit.Jahr = '2005' OR
      Zeit.Jahr = '2006' AND
      Zeit.Monat = '12';
```

Figure 1: DWH-Query.

2. Discuss optimization strategies for Star Joins.
3. Which optimal execution plan do standard query optimizers leave out?

Exercise 3: Explain optimization strategies for GROUP BY operations.

Exercise 4: Write down the aggregation grid for the dimensions Product, Region, Day and Sales.

Exercise 5: Explain the principle of Pipesort.