Query Optimization Tutorial

Database Schema

Customer(ID, Name, Type)	10,000
(8, 30, and 5 bytes each)	
Invoice(InvID, CustID, Date, Amount)	10 per customer per month
(12, 8, 10, and 5 bytes each)	
LineItem(InvID, LineNo, ProdID, Qty)	10 per invoice
(12, 5, 20, and 5 bytes each)	
Product(ProdID, Description, ProdType)	1000
(20, 40, and 5 bytes each)	

Assume that each pointer uses 10 bytes. Each block is 256 bytes. Further, there are 10 distinct values of ProdType in Product, and 5 distinct values of Type in Customer.

a) How many tuples/blocks are there in each table?

Customer
Invoice
LineItem
Product

b) How many tuples are there in the natural join of Customer, Invoice, LineItem, and Product? Also, how many block in each join?

1. |Customer join Invoice| =
2. (1.) join |LineItem| =
3. (2.) join Product| =

Which relation affects the size of the result the most?

c) What would be the cost (in block reads) of computing this natural join, step by step, in the sequence indicated (1->2->3)? Is there another sequence that would cost more?

Note 1 The sort-merge join is to be used (n + n log n + m + m log m) with log based 2.
Note 2 Also, assume that the intermediate query result is written to the disk each time.

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d) Suppose that a flat-file index is to be created for Invoice.CustID, re-assess the cost of the join number 1 (Customer join Invoice).
Note from now on, the join number 1 can use index if needed.

Cost index = n+10 k (log2(i)+9+m) and N = 2000 blocks

BFR I = 14

Entry invoice = 1,200,000

I = 1,200,000/14

= 85,715 blocks

Index block = 120/14 = 9

Entry M = 120

the cost is 1,462,000.00

e) Suppose we want to know the types of customers which have bought a given type of product (widget) in July. How many tuples would you expect in the result?
Ans. at most 5

f) From the query in e), what joins are remaining, in increasing order of cost?

A = Customer join invoices (for July),
cost = Join(2000, 14,286) = 235,398.00 ,
the number of tuples/blocks in result 14,286.
(*above join can use index if more efficient*)

B = invoices (for July) join LineItem,
cost =Join(14,286 , 2,000,000) = 44,074,604.00,
the number of tuples/blocks in result 2,000,000.

C = (LineItem for July) join (products of given type),
cost = Join(166,667 , 334) = 3,057,982
the number of tuples/blocks in result 166,667.

The final join can be done on A and C:
A join C, cost = Join(14,286, 166,667)= 3,269,241 ,
the number of tuples/blocks in result 166,667.

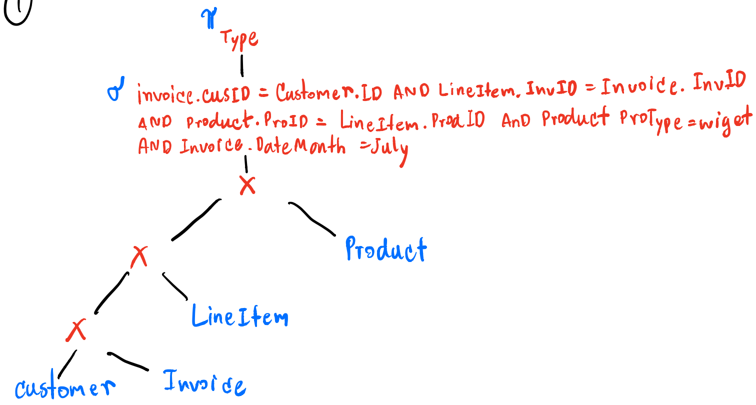
g) From the query in d), its SQL statement is:

```
SELECT Type
FROM    Customer, invoice, LineItem, Product
WHERE  Invoice.CustID = Customer.ID AND
            LineItem.InvID = Invoice.InvID AND
            Product.ProdID = LineItem.ProdID AND
            Product.ProdType = Widget  AND
            Invoice.Date.Month = July
```

Construct a query tree for this query, and show the steps in heuristic optimization.

(g)

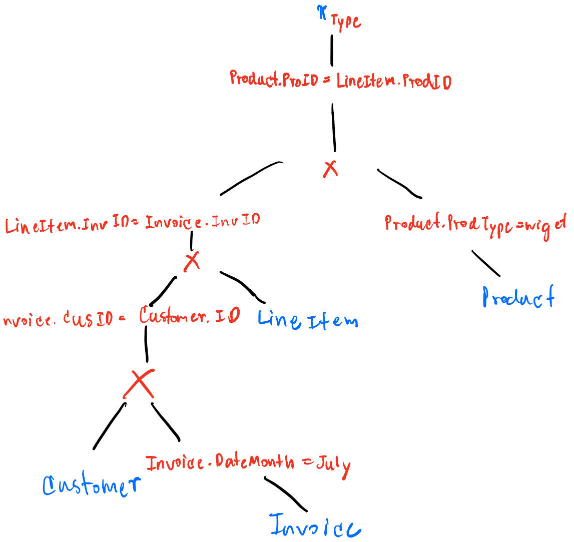
①



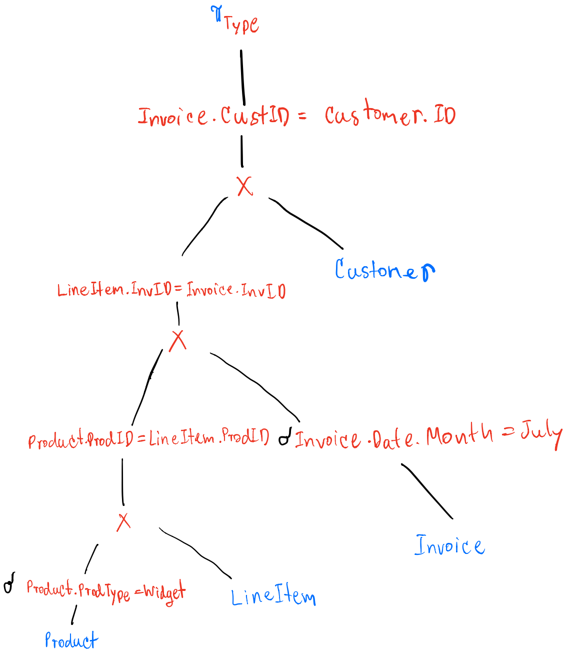
γ Type
σ invoice.cusID = Customer.ID AND LineItem.InvID = Invoice.InvID
AND Product.ProID = LineItem.ProdID AND Product ProType = wiget
AND Invoice.DateMonth = July
X
Product
X
LineItem
X
customer
Invoice

②

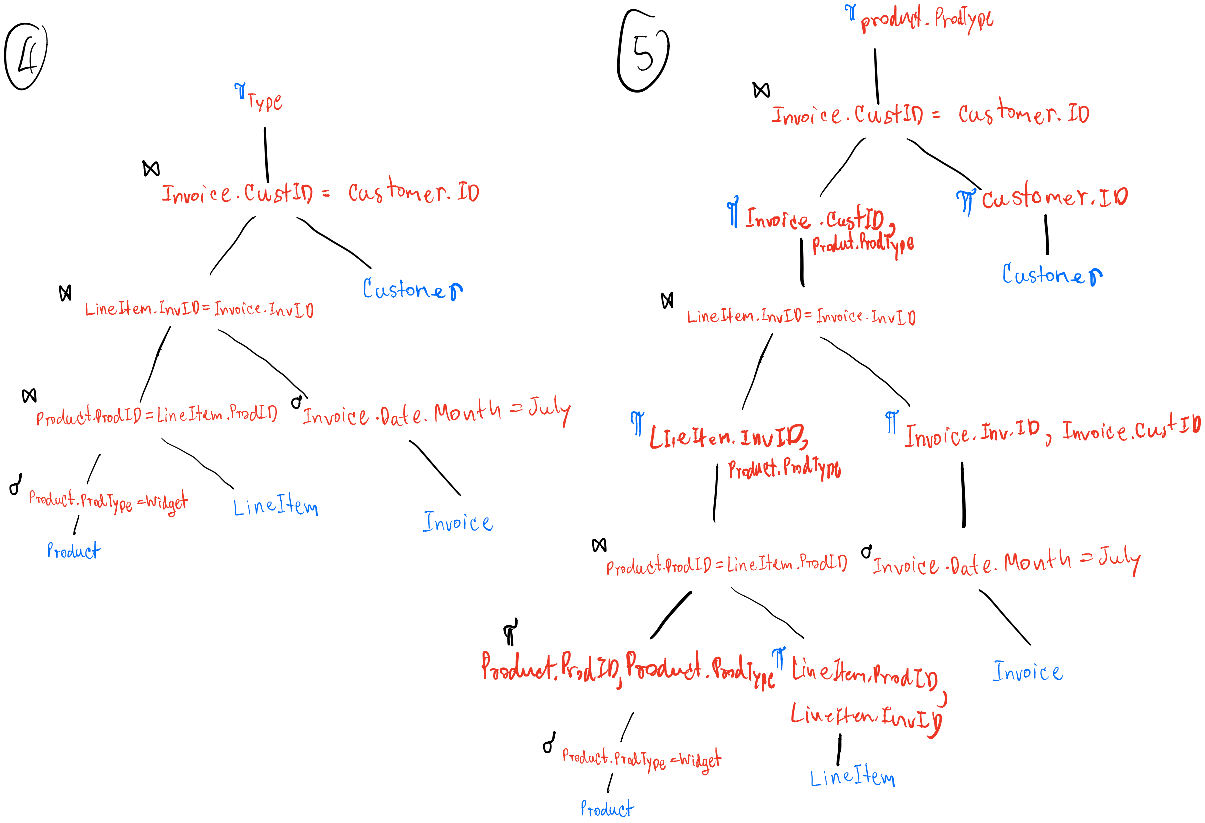
③



γ Type
Product.ProID = LineItem.ProdID
X
LineItem.InvID = Invoice.InvID
Product.ProdType = wiged
X
nvoice.cusID = Customer.ID
LineItem
Product
X
Customer
Invoice.DateMonth = July
Invoice



γ Type
Invoice.CustID = Customer.ID
X
Customer
LineItem.InvID = Invoice.InvID
X
Product.ProdID = LineItem.ProdID
σ Invoice.Date.Month = July
X
Invoice
σ Product.ProdType = Widget
LineItem
Product


4
π Type
⋈ Invoice.CustID = Customer.ID
⋈ LineItem.InvID = Invoice.InvID
Customer
⋈ Product.ProdID = LineItem.ProdID
σ Invoice.Date.Month = July
σ Product.ProdType = Widget
LineItem
Invoice
Product
5
π product.ProdType
⋈ Invoice.CustID = Customer.ID
π Invoice.CustID, Product.ProdType
π customer.ID
Customer
⋈ LineItem.InvID = Invoice.InvID
π LIeItem.InvID, Product.ProdType
π Invoice.Inv.ID, Invoice.CustID
⋈ Product.ProdID = LineItem.ProdID
σ Invoice.Date.Month = July
π Product.ProdID, Product.ProdType
π LineItem.ProdID, LineItem.InvID
Invoice
σ Product.ProdType = Widget
LineItem
Product

h) From the optimized query tree in g), suppose that the system can read and write data from disk with 40,000 and 20,000 block/second respectively. How long does it take to execute the query?

From step e in g)

step		cost
1	O(n+log N)	343.00
2	O(n)	334.00
3	O(n)	166,667.00
4	join	3,060,909.00
5	O(n + log N)	14,300.00
6	O(n)	14,286.00
7	O(n)	166,667.00
8	join	3,269,241.00
9	O(n)	166,667.00
10	O(n)	2,000.00
11	join	3,081,706.00
12	O(n)	166,667.00
total cost		1,384,647block

Read disk take time 1,384,647/40,000 = 35 second
Write disk take time 1,384,647/20,000 = 70 second
Ans**.** This query take time 105 second