Query Optimization: Exercise

Session 6

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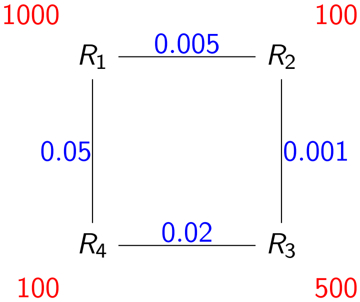
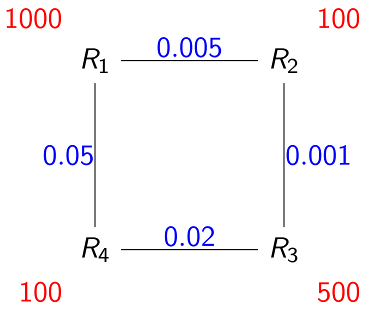
Maximum Value Precedence (MVP) [1]

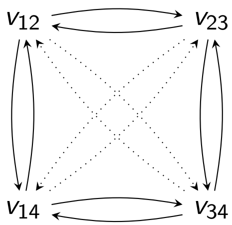
Weighted Directed Join Graph (WDJG)



Query graph to $WDJG = (V, E_p, E_v)$:

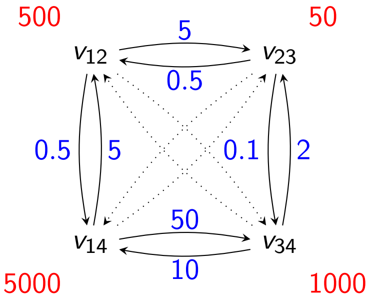
- nodes V = joins
- physical edges E_p between "adjacent" joins (share one relation)
- virtual edges E_v everywhere else
- $\mathcal{R}(v)$: relations participating in join v
- Observation: every spanning tree in the WDJG leads to a join tree


1000
100
R_1
0.005
R_2
0.05
0.001
R_4
0.02
R_3
100
500


v_{12}
v_{23}
v_{14}
v_{34}

Weights and Costs:

- edge weights:
$$w_{u,v} = \begin{cases} \frac{|\bowtie_u|}{|\mathcal{R}(u) \cap \mathcal{R}(v)|} & \text{if } (u,v) \in E_p \\ 1 & \text{if } (u,v) \in E_v \end{cases}$$
- node costs: C_{out} of the join



Effective Spanning Tree (EST)

Three conditions:

1. EST is binary
2. For every non-leaf node v_i, for every edge $v_j \rightarrow v_i$ there is a common base relation between v_i and the subtree with the root v_j
3. For every node $v_i = R \bowtie S$ with two incoming edges $v_k \rightarrow v_i$ and $v_j \rightarrow v_i$
    - R or S can be present at most in one of the subtrees v_k or v_j
    - unless the subtree v_j (or v_k) contains both R and S

MVP - informally

Construct an EST in two steps:

Step 1 - Choose an edge to reduce the cost of an expensive operation

- Start with the most expensive node
- Find the incoming edge that reduces the cost the most
- Add the edge to the EST and check the conditions
- Update the WDJG
- Repeat until
  - no edges can reduce costs anymore or
  - no further nodes to consider

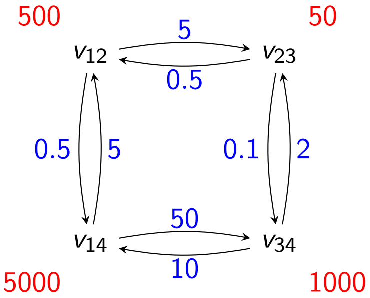
Step 2 - Find edges causing minimum increase to the result of joins

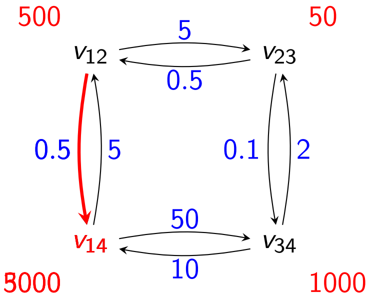
- Similar to Step 1
- Start with the cheapest node
- Find the incoming edge that increases the cost the least

Example

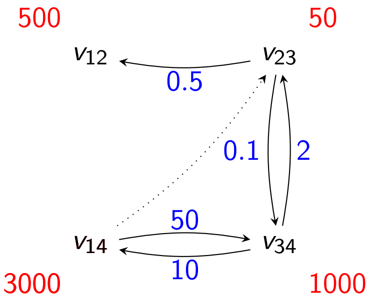
We start with a graph without virtual edges.
Two cost lists:

- for the Step 1: $Q_1 = v_{14}, v_{34}, v_{12}, v_{23}$
- for the Step 2: $Q_2 = \emptyset$

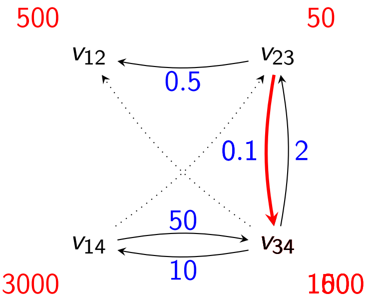


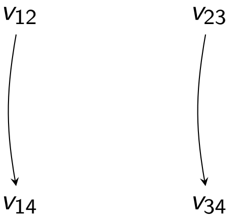


$Q_1 = v_{14}, v_{34}, v_{12}, v_{23}$; $Q_2 = \emptyset$
Consider v_{14}, select the edge $v_{12} \rightarrow v_{14}$
After v_{12} is executed, $|R_1 \bowtie R_2| = 500$
Replace R_1 by $R_1 \bowtie R_2$ in $v_{14} = R_1 \bowtie R_4$: $v_{14} = (R_1 \bowtie R_2) \bowtie R_4$
$cost(v_{14}) = 500 * 100 * 0.05 + 500 = 3000$



Move $v_{12} \rightarrow v_{14}$ to EST
Update WDJG, remove edges $v_{14} \rightarrow v_{12}$ and $v_{12} \rightarrow v_{23}$, add edge $v_{14} \rightarrow v_{23}$
$Q_1 = v_{14}, v_{34}, v_{12}, v_{23}$; $Q_2 = \emptyset$
Consider v_{14}, no more incoming edges with $w < 1$
$Q_1 = v_{34}, v_{12}, v_{23}$; $Q_2 = v_{14}$





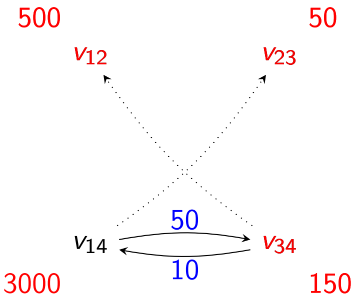
$Q_1 = v_{34}, v_{12}, v_{23};\ Q_2 = v_{14}$

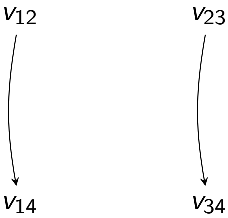
Consider v_{34}, select the edge $v_{23} \rightarrow v_{34}$

Recompute cost: $cost(v_{34}) = 50 * 100 * 0.02 + 50 = 150$

Move to EST, Update WDJG

$Q_1 = v_{12}, v_{34}, v_{23};\ Q_2 = v_{14}$





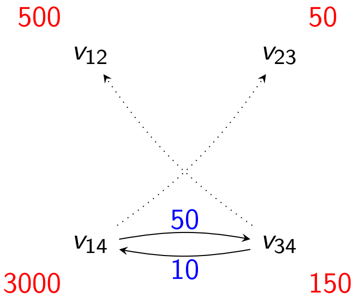
$Q_1 = v_{12}, v_{34}, v_{23}$; $Q_2 = v_{14}$

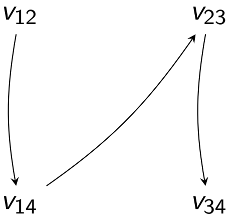
Consider v_{12}, no edges

v_{34}, v_{23}: no incoming edges with $w < 1$

$Q_1 = \emptyset$; $Q_2 = v_{23}, v_{34}, v_{12}, v_{14}$

End of Step 1





$Q_2 = v_{23}, v_{34}, v_{12}, v_{14}$
Consider v_{23}, edge $v_{14} \rightarrow v_{23}$
Adding the edge would not violate EST conditions
Add edge to EST
Done.

Dynamic Programming

Overview

- generate optimal join trees bottom up
- start from optimal join trees of size one (relations)
- build larger join trees by (re-)using optimal solutions for smaller sizes

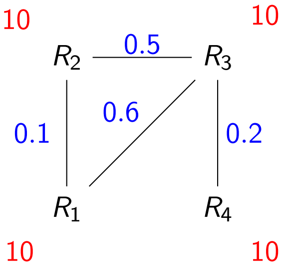
First Approach: DPsizeLinear [2]

- Enumerate increasing in size
- Generate linear trees by adding a single relation at a time

Modifications/Extensions:

- enumerate in integer order
- generate bushy trees by considering all pairs of subproblems

Example


10
10
R2
0.5
R3
0.1
0.6
0.2
R1
R4
10
10

- Enumerate connected-subgraph-complement pairs
- Query Simplification
- Reordering constraints for non-inner joins

- Remember to bring your laptop for the lecture evaluation next week

- Slides and exercises: db.in.tum.de/teaching/ws1718/queryopt
- Send any questions, comments, solutions to exercises etc. to radke@in.tum.de
- Exercise due: 9 AM, December 4

[1] C. Lee, C. Shih, and Y. Chen.
Optimizing large join queries using A graph-based approach.
IEEE Trans. Knowl. Data Eng., 13(2):298–315, 2001.

[2] P. G. Selinger, M. M. Astrahan, D. D. Chamberlin, R. A. Lorie, and T. G. Price.
Access path selection in a relational database management system.
In *Proceedings of the 1979 ACM SIGMOD International Conference on Management of Data, Boston, Massachusetts, May 30 - June 1.*, pages 23–34, 1979.