

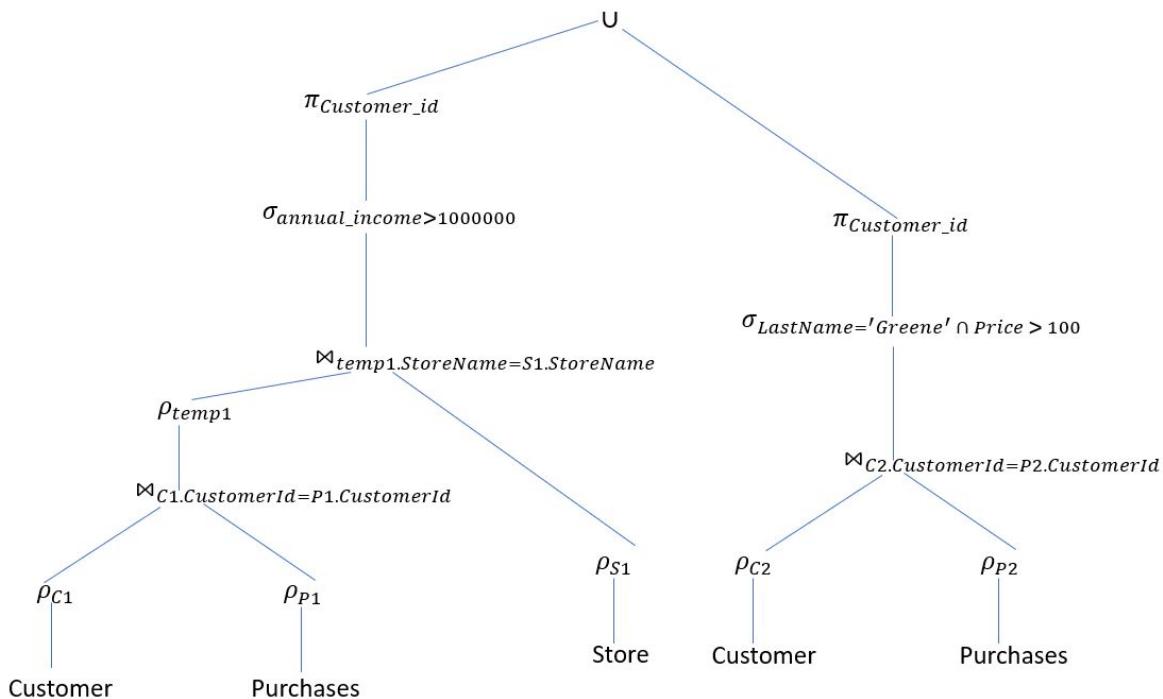
1. a.

$$\pi_{name, dept\_name}(Teaches \bowtie \sigma_{salary > 75} Instructor \bowtie (\pi_{course\_id}(Takes \bowtie (\sigma_{credit < 50} Student))))$$

b.

$$\pi_{course\_id, room\_num}(Teaches \bowtie Course \cap (\pi_{course\_id}(\sigma_{dept\_name <> 'History'}(Student \bowtie Takes)) \cap (\pi_{course\_id}(\sigma_{credits=4} Teaches \bowtie Course))))$$

2.



3.

Step 1:

[10,6,13], [14,20,19], [27,11,1] => output sorted run1 [1,6,10], [11,13,14], [19,20,27]  
 [17,29,12], [16,25,2] => output sorted run2 [2,12,16], [17,25,29]

Step2:

[1,6,10] [2,12,16] => [1,\_,\_]

$[1,6,10] [2,12,16] \Rightarrow [1,2,\_]$   
 $[1,6,10] [2,12,16] \Rightarrow [1,2,6] \Rightarrow \text{output}$   
 $[1,6,10] [2,12,16] \Rightarrow [10,\_,\_]$   
 $[11,13,14] [2,12,16] \Rightarrow [10,11,\_]$   
 $[11,13,14] [2,12,16] \Rightarrow [10,11,12] \Rightarrow \text{output}$   
 $[11,13,14] [2,12,16] \Rightarrow [13,\_,\_]$   
 $[11,13,14] [2,12,16] \Rightarrow [13,14,\_]$   
 $[19,20,27] [2,12,16] \Rightarrow [13,14,16] \Rightarrow \text{output}$   
 $[19,20,27] [17,25,29] \Rightarrow [17,\_,\_]$   
 $[19,20,27] [17,25,29] \Rightarrow [17,19,\_]$   
 $[19,20,27] [17,25,29] \Rightarrow [17,19,20] \Rightarrow \text{output}$   
 $[19,20,27] [17,25,29] \Rightarrow [25,\_,\_]$   
 $[19,20,27] [17,25,29] \Rightarrow [25,27,\_]$   
 $[19,20,27] [17,25,29] \Rightarrow [25,27,29] \Rightarrow \text{output}$

Result:

$[1,2,6], [10,11,12], [13,14,16], [17,19,20], [25,27,29]$

$$4. 50+100*50/(30-2) = 228.5714$$

5. a.

$$\pi_{S.NetId} \left( \begin{array}{c} (\sigma_{S.Department='CS'} Students \bowtie_{S.NetId=E.NetId} \\ ((\sigma_{E.Credits=4} Enrollments)) \bowtie_{E.CRN=C.CRN} (\sigma_{C.Department='ECE'} Courses) \end{array} \right)$$

b.

$$\pi_{S.FirstName} ((\sigma_{E.NetId = 'c\%'} \cap E.Score > 90) Enrollments) \bowtie Students$$

6.

Subquery	Size	Cost	Plan
AB	45K	0	BA
AC	12M	0	AC
AD	600K	0	AD
BC	120K	0	BC

BD	12M	0	BD
CD	160K	0	CD
ABC	3.6M	45K	(BA)C
ABD	9M	45K	(BA)D
ACD	12M	160K	(CD)A
BCD	4.8M	120K	(BC)D
ABCD	3.6M	3645K	(BAC)D