

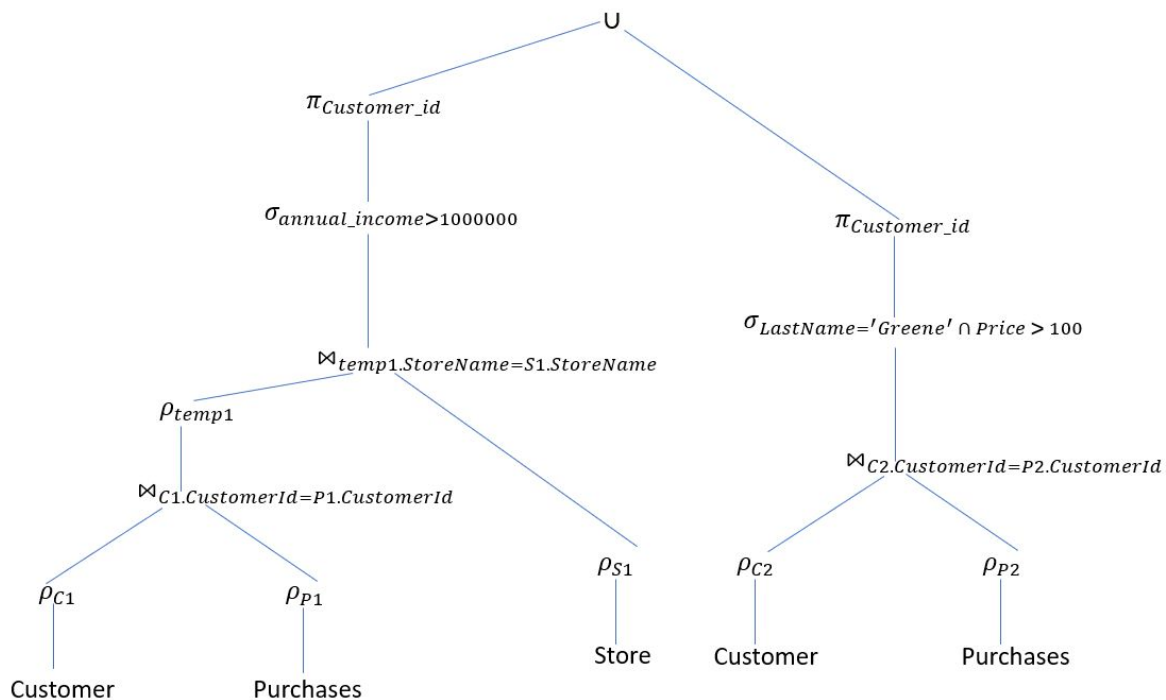
1. a.

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

b.

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

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] => [1,2,]  
 [1,6,10] [2,12,16] => [1,2,6] => output  
 [1,6,10] [2,12,16] => [10,\_,]  
 [11,13,14] [2,12,16] => [10,11,]  
 [11,13,14] [2,12,16] => [10,11,12] => output  
 [11,13,14] [2,12,16] => [13,\_,]  
 [11,13,14] [2,12,16] => [13,14,]  
 [19,20,27] [2,12,16] => [13,14,16] => output  
 [19,20,27] [17,25,29] => [17,\_,]  
 [19,20,27] [17,25,29] => [17,19,]  
 [19,20,27] [17,25,29] => [17,19,20] => output  
 [19,20,27] [17,25,29] => [25,\_,]  
 [19,20,27] [17,25,29] => [25,27,]  
 [19,20,27] [17,25,29] => [25,27,29] => 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.

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

b.

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

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