Is my friend correct?
Can you show me the evidence by building an index for the second letter.

Here are some parameters you may or may not need
1. Each index page can record 200 words
2. there are 12,000 words that has 5 letters, taking 50 pages
3. the selection factor is 0.05

How about I make 5 copies of the list and sort them on specific position? (so list 1 is sorted on the first letter, list 2 is sorted on the second letter, etc). Is indexing still better? Which option requires less space? And which option is more efficient?

B tree index dense

12000 <sk, pnt> pairs

60 data entry nodes

1 directory node

If sk is just the second letter

query result ≥ 600 words

index read root + 3 data entry = 4 pgs.

data read 600 pgs

not good.

If sk is the entire word

index read root + 3 dataEntry = 4pgs

no need to read data

1

5 sorted file = 3005 = 250 pg.

5 dense index = 61×5 = 305 pg

if use index, still need the original data 50pg.

search on sorted file total 355pg.

$\log_2(50)+3$

We have the following relations

Students

snum	name	gender
1001	Randy	M
1005	Nicole	F

Departments

dcode	Dpt_name	college
403	Chemical Engineering	Engineering
402	Mathematics	LAS
404	Landscape Architect	Design
401	Computer Science	LAS

Degree

name	level	dcode
Computer Science	BS	401
Computer Science	MS	401
Computer Science	PhD	401
Software Engineering	BS	401
Landscape Architect	BS	404
Chemical Engineering	BS	403
Applied Mathematics	MS	402

Major

snum	name	level
1005	Computer Science	MS
1001	Software Engineering	BS

Minor

snum	name	level
1001	Computer Science	BS
1005	Applied Mathematics	MS

Courses

cnum	cname	description	cdt	level	dcode
113	Spreadsheet	Microsoft Excel and Access	3	Undergraduate	401
311	Algorithm	Design and Analysis	3	Undergraduate	401
531	Theory of Computation	Theorem and Probability	3	Graduate	401
363	Database	Design Principle	3	Undergraduate	401
412	Water Management	Water Management	3	Undergraduate	404
228	Special Topics	Interesting Topics about CE	3	Undergraduate	403
114	Calculus	Limit and Derivative	4	Undergraduate	402

Registers

snum	cnum	dcode	semester	grade
1001	228	403	Spring2015	4
1005	114	402	Spring2015	4
1005	113	401	Spring2015	4
1001	363	401	Fall2015	3.8

(a) optimize relational algebra expressions for the following queries

i. Find the names and levels of degrees offered by LAS

$\Pi_{name, level}(\sigma_{college=LAS}(Dept) \bowtie Deg)$

ii. Find the department names that offer both graduate and undergraduate courses

$\Pi_{name}(\sigma_{level=grade}(courses) \bowtie Dept \cap \sigma_{level=undergrad}(courses) \bowtie Dept)$

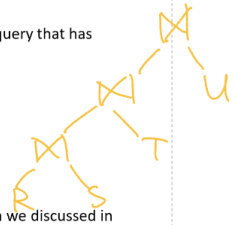
You are given four schemas R(a, b, c), S(b, d), T(b, e), U(b, f).

(b) Consider the following SQL query

```
SELECT   *
FROM     R, S, T, U
WHERE    R.b = S.b
         AND S.b = T.b
         AND T.b = U.b
```

i. Write the relational algebra for this query. Draw a left-deep plan for the query that has selection pushed down.

$R \bowtie S \bowtie T \bowtie U$



ii. How many left-deep plans will be considered by the IBM System R (which we discussed in our lectures)? You need to explain why in order to receive points.

4!

Derive the I/O costs of different join algorithms of relations R and S given the following variables, which you may or may not use all of them. Ignore the CPU time costs and the cost of writing the results. Write down steps for partial credits

|R|=10: Number of tuples per page in R
|S|=20: Number of tuples per page in S
M=200: Number of pages in R
N=40: Number of pages in S
B=10: Number of available memory in pages

c). What is the procedure Sort-Merge Join? What is the minimal I/O cost?

sort R and S if they are not sorted

merge R and S

sort R cost: pass 1 200/10 = 20 sorted subfiles
pass 2 merge 9 files into 1. 3 sorted files
pass 3 merge 3 files into 1

2×3×M = 1200

Sort S cost: 2×2×40 = 160

merge R, S : M+N = 240

total cost = 240 + cost of sorting (R) + cost of sorting (S)

d). (4 points) If the number of available memory in pages B increase to 20, and other assumptions remain the same

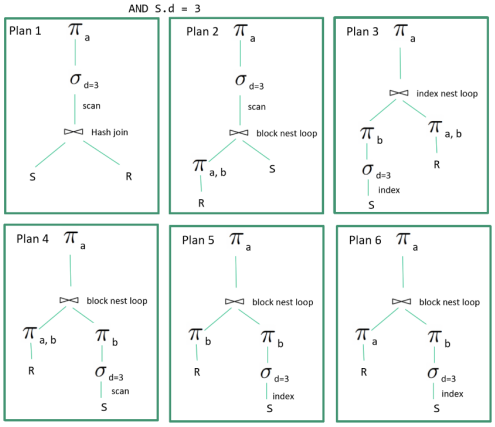
1) the minimal I/O cost of block nested loop join will
increase[ ] decrease[√] do not change[ ]
2) the minimal I/O cost of simple nested loop join will
increase[ ] decrease[√] do not change[ ]
3) the minimal I/O cost of grace hash join will
increase[ ] decrease[ ] do not change[√]
4) the minimal I/O cost of Sort-Merge join will
increase[ ] decrease[ ] do not change[ ]

3

if no need to sort R: do not change
if need to sorted R: decrease

(a) Consider the following SQL query and evaluation plans

```
SELECT  R.a
FROM    R, S
WHERE   R.b = S.b
        AND S.d = 3
```



i. Which plan(s) is not correct (i.e., producing wrong results)? You need to explain why in order to receive points. 5 & 6

5. Π_b removed field a before join

6. Π_a Π_b cannot join

ii. Which plan is likely to be the most efficient? You need to explain why in order to receive points. Can you estimate the I/O cost for the plans?

3 better than 4 better than 1 or 2

3. use index to select d=3. d is primary key, so selection result is a single record
R has index on b, and b is unique for R. so just need to look up for a single record using index.